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Preliminary Models Reduce Machine-Design Costs

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Intricate shapes difficult to visualize from drawings alone—Models may be full size or to reduced scale—Examples of models and machines

PRELIMINARY models of new machines are often made before the machines are manufactured on a production basis. The model is usually made to serve for one or more of the following purposes:

1—To visualize the proportions and general lines of the machine.

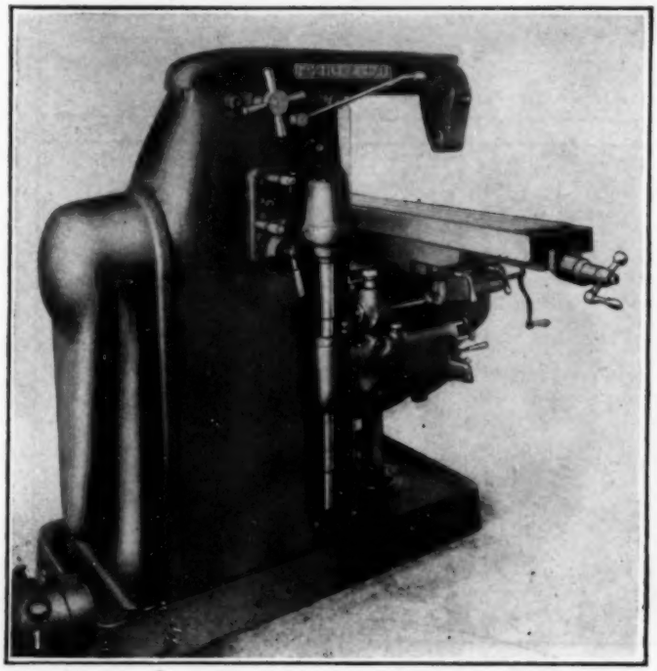
2—To determine proper clearances between moving parts of the mechanism.

3—To determine the relative motions of the parts of complicated mechanisms.

4—To test operating characteristics.

When the primary purpose is to determine and visualize the proportions, full-size models are often constructed, but frequently they are built to a reduced scale. The material for the large parts is usually wood, covered with artist's wax. Small parts are generally made entirely of wax, though stock parts from other machines may be used on full sized models. In either case it is a simple matter to alter the general lines of a machine or of its parts, to produce the desired proportions and pleasing lines. The models may be painted and photographed for purposes of record and for further study of the proportions. Sometimes it is difficult to distinguish between a model and the actual machine.

An example of a full-size preliminary model is shown in Fig. 1. The model was built in developing the No. 2-M plain Cincinnati milling machine with column-enclosed motor drive. The machine as produced for the



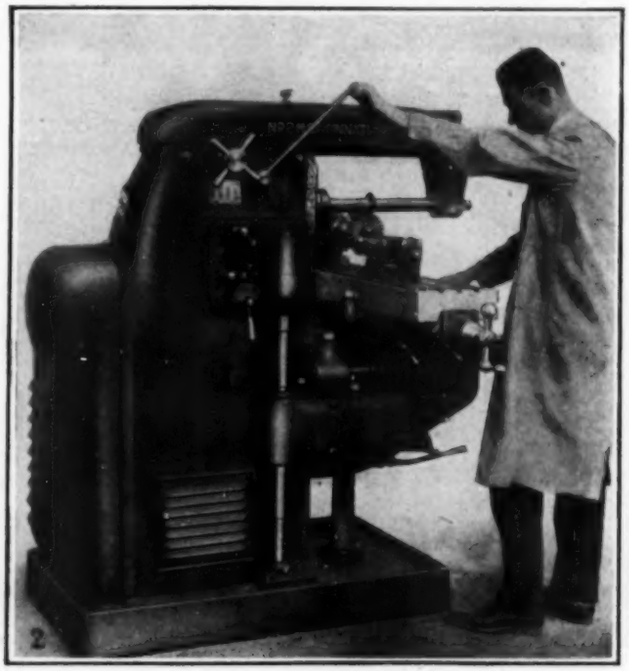


Fig. 1—Full-size model of milling machine. Fig. 2—The complete machine

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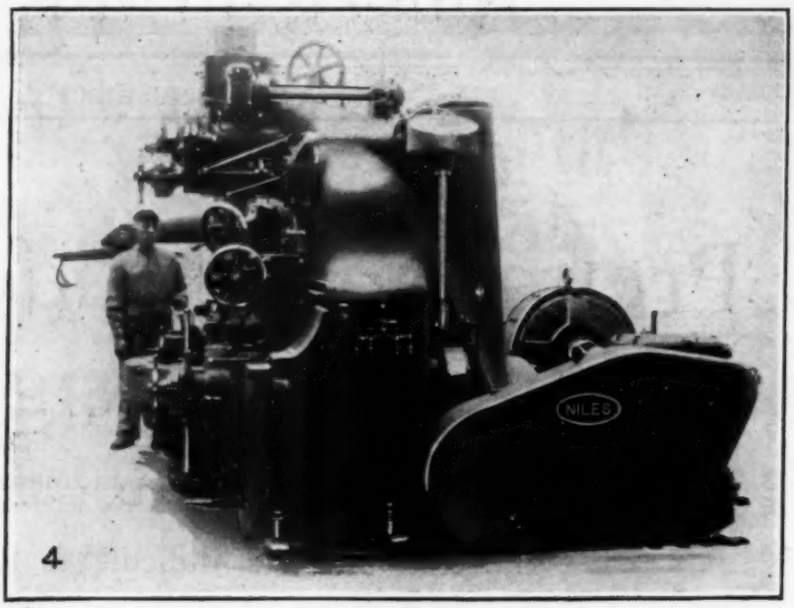

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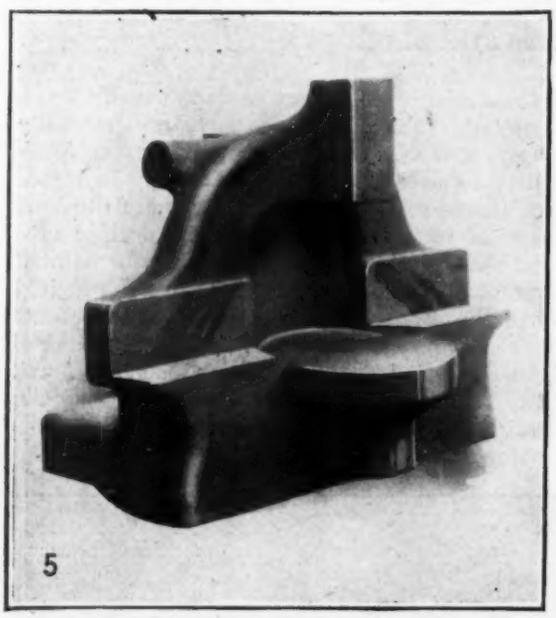

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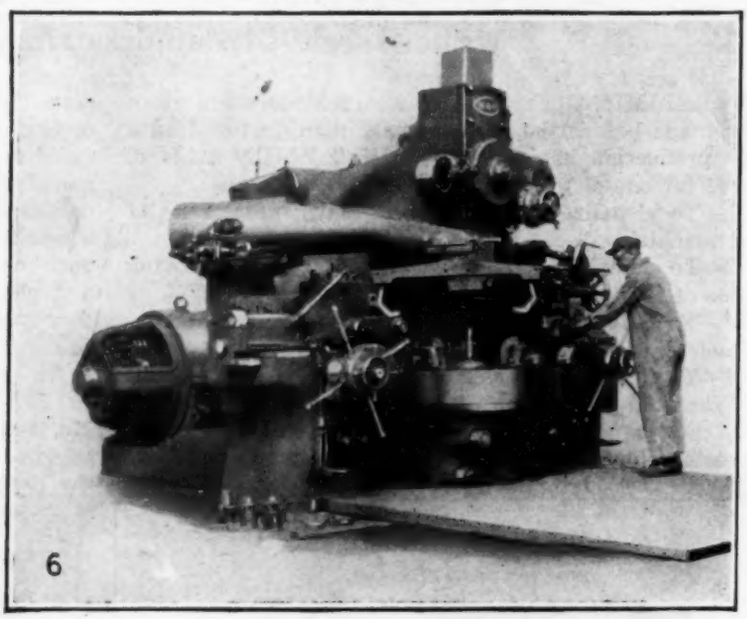

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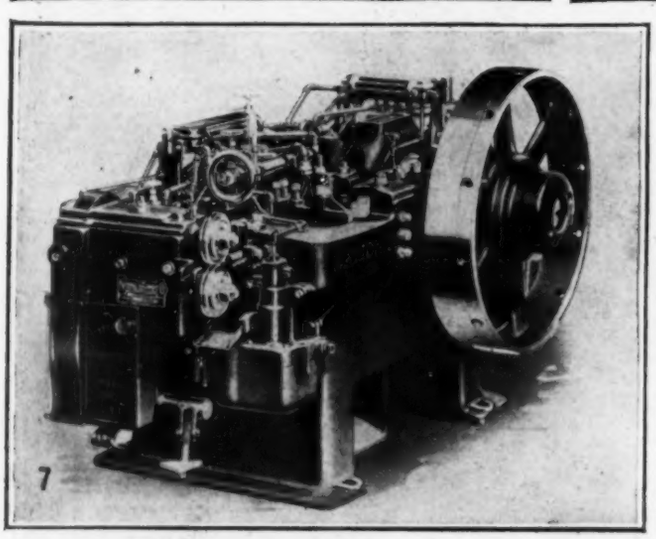

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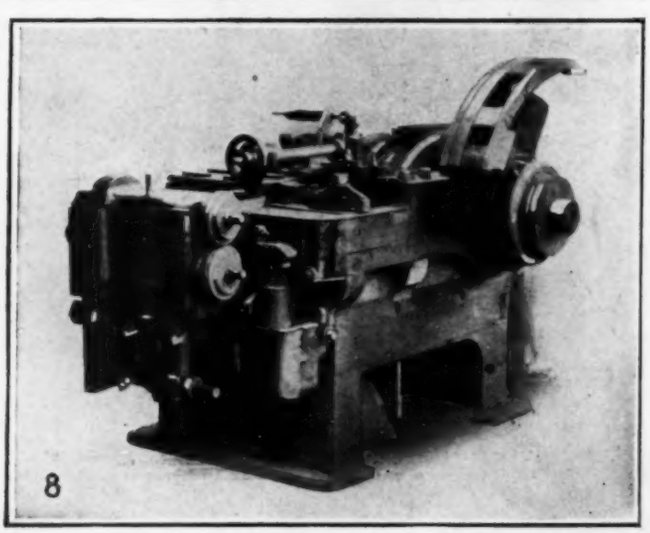

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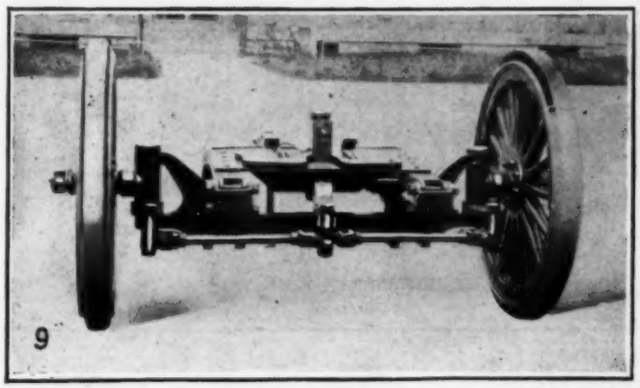
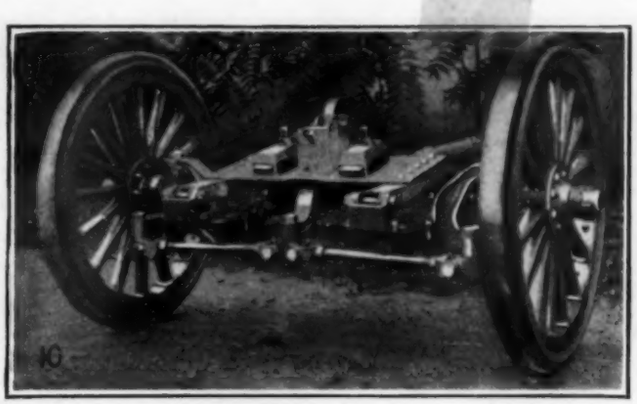
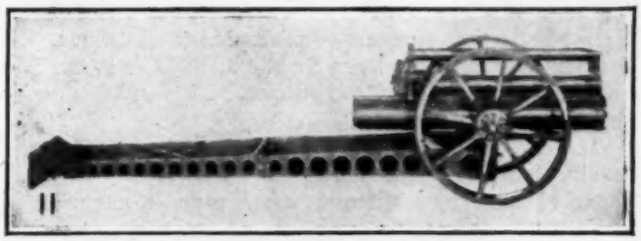
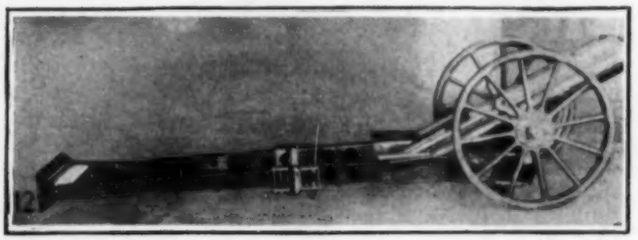
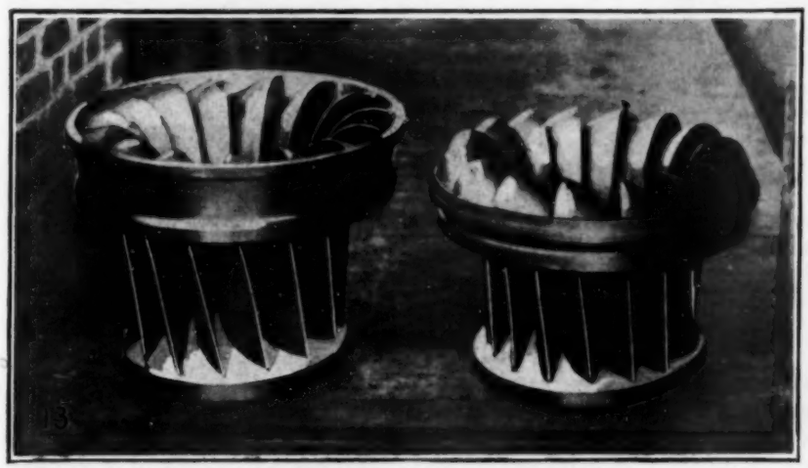
Figs. 3 and 5—Reduced-scale models of frame of car wheel boring machine. Figs. 4 and 6—Car wheel boring machine developed from model. Fig. 7—Machine for heading bolts and rivets Fig. 8—Model from which the heading machine was developed

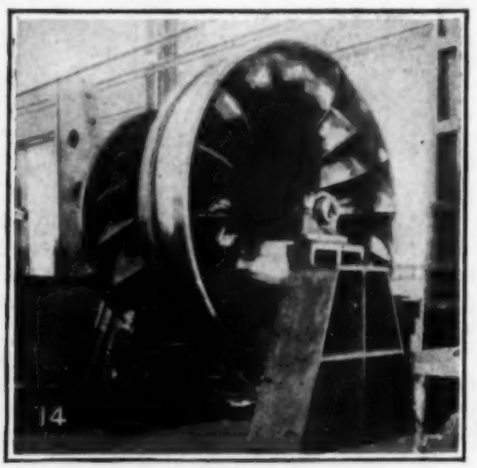


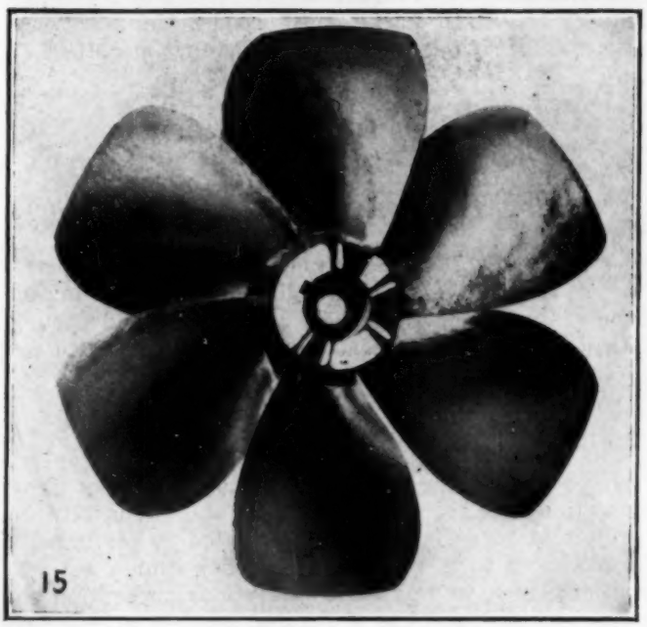












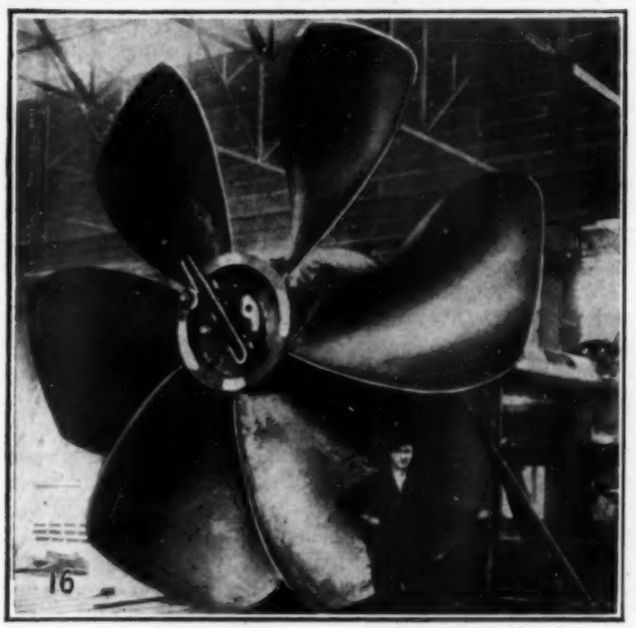
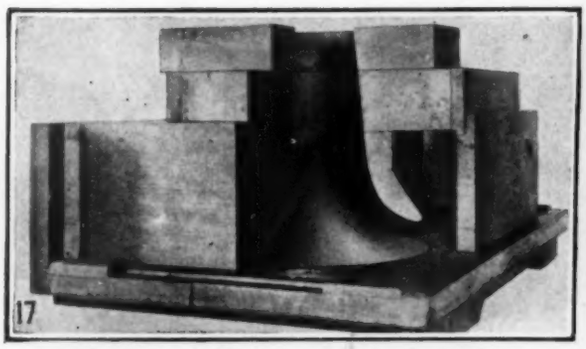


Fig. 9—Full-size model of a gun limber. Fig. 10—Finished gun limber. Fig. 11—Full-size model of a gun carriage. Fig. 12—Finished gun carriage. Fig. 13—Two models of turbine runners. Fig. 14—The completed runner. Fig. 15—Model of a high-speed turbi ne runner. Fig. 16—The finished runner



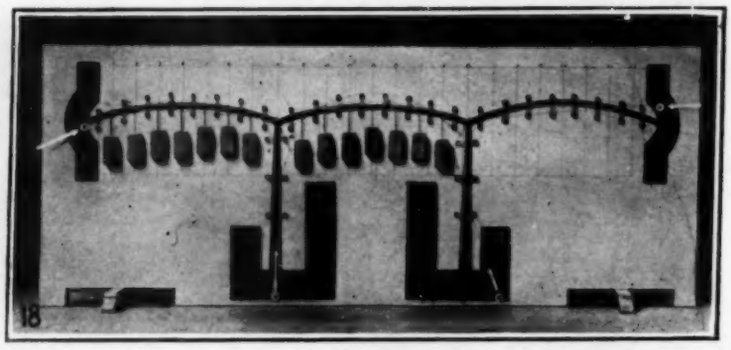


Fig. 17—Model of Moody draft tube, cut open for inspection. Fig. 18—Celluloid model for determining load stresses in bridges

market is shown in Fig. 2. Before the ventilator was added to the motor-drive cover, a wax model was made for study.

Sometimes, in cases of very large machines, the models are built to a reduced scale. The carwheel boring mill developed by the Niles Tool Works is an example of this practice. Photographs of the wood model are shown in Figs. 3 and 5 and the corresponding views of the finished machine are shown in Figs. 4 and 6. The value of preliminary models is apparent in these machines, for it would be very difficult to visualize from the drawings the appearance of machines in which the lines are so broken as in these examples. Referring to these models, it should be mentioned that sometimes the models do not include all details of the machine, as in this case.

The rivet header made by the National Machinery Co. illustrated in Fig. 7 is another example of a machine that would be difficult to visualize from the drawing. In Fig. 8 is shown the wooden model from which it was developed.

Sometimes the principal purpose of a model is to check a train of mechanism for proper relative motions of the component members, and to determine whether proper clearances have been allowed between moving parts. In cases of this kind a full-size model of the mechanism alone is made, without constructing a model of the entire machine. Often a working model may be made from cardboard or celluloid, to check the operation of linkages.

In Fig. 9 is a full-size model of a gun limber, and in Fig. 10 is shown the finished limber developed from the model. Likewise, Figs. 11 and 12 show, respectively, a model and a finished carriage for a 2.24-in. infantry howitzer. The models were built at the Rock Island Arsenal.

Another important function of a model may be to make a preliminary determination of operating characteristics. As an example, models to a reduced scale are constructed of all large boats, and the models are pulled through the water in a testing flume to determine the power required and the effects of changes in the shapes of the hulls. Similarly, models of airplanes and airships are placed in wind tunnels so that their characteristics may be studied. In the field of power machinery, we have an excellent example of the testing of preliminary models of hydraulic turbines and pumps. After a large turbine has been designed, a small turbine is constructed, geometrically similar in every detail. From the efficiency and operating characteristics of the model, a very close prediction may be made of the operation of the finished turbine.

In Fig. 13 are shown two preliminary models for the runner of a turbine, built by the I. P. Morris Co. and in Fig. 14 is the completed runner. This turbine developed 20,000 horsepower.

The model and full-size, high-speed runner, respectively, shown in Figs. 15 and 16, were built by the I. P. Morris Co. The turbine developed 28,000 hp. as installed.

The efficiency of a turbine is considerably influenced by the shape of the casing and of the draft tube. Wood models of these parts are generally made in 16-in. sizes so they may be tested with the model runners, but tests are often made without runners on 4-in. models of draft tubes. Fig. 17 shows the model of a Moody draft tube cut open for inspection.

The civil engineer is finding the model useful in determining the stresses in bridge and construction members due to loads. This method is simple and saves much tedious calculation. Loads are applied to the model and the deflections in members are read through a miscroscope. Fig. 18 shows a celluloid model used for the study of the stresses in a bridge.

The value of the use of models is apparent. Their first cost is much lower than that of making the first machine of castings, and they facilitate the making of trial design and numerous alterations at a comparatively low cost. Parts of the wood model may sometimes be used as the patterns for the first machine.

Vacations for Wage Earners

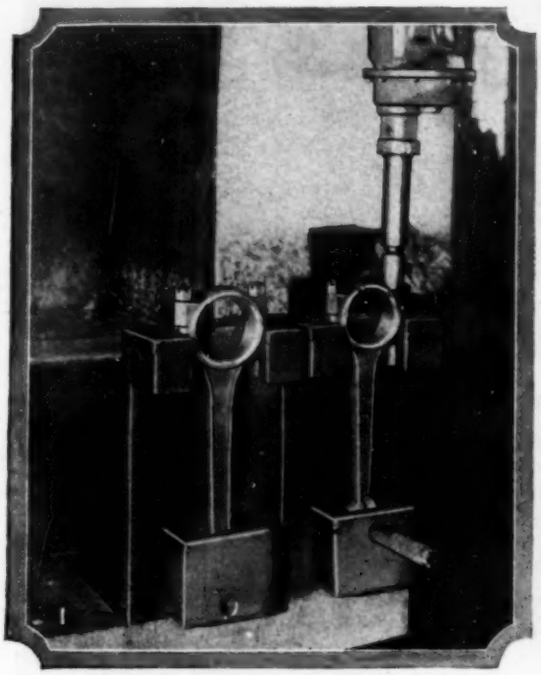
By John Homewood

"Well, Bill, where did you go on your vacation this summer?"

"Vacation! Don't make me laugh; you know I can't afford to take one," replied Bill as he proceeded to take the casting from the chuck. "Need one bad enough, Lord only knows; feel all in when it gets 'round five o'clock."

Why should there be a difference in the treatment of salaried employees and those working by the hour? This question is not asked in the interest of the employee alone. The purpose of having employees go on vacation is to recreate their bodies and minds with the object of rendering them better fitted to perform the tasks upon their return. The writer cannot see why an employee, who by his conscientious application and sincerity is classed as a regular member of the firm, should not be considered as being worthy of "upkeep." It is an investment that is conducive of great returns in less turnover, greater loyalty, and better workmen.

Automotive Production



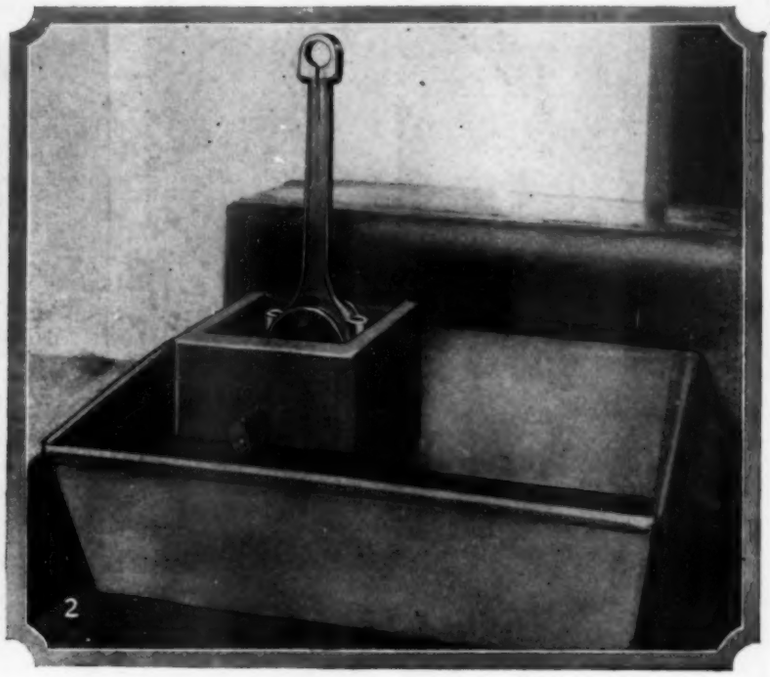


Fig. 1—Separating the rod and the cap. Fig. 2—Applying the acid

How Production Methods Vary in Shops Building "Light Sixes"

By Fred H. Colvin
Editor, *American Machinist*

PUTTING the finishing touches on connecting rods gives opportunities for time-saving tools and fixtures. This article shows how some of these opportunities have been taken advantage of by the tool designers of both the Cleveland and the Oakland plants.

In the Cleveland plant, after the rods have been machined and are ready for babbitting, they go to the department where this work is done. Here the first operation is to separate the rods and caps, the method being shown in Fig. 1. The fixture holds rods of two sizes, the lower ends being held by pins through the small holes. The air motor is so suspended as to be easily handled and the nuts are taken off very rapidly.

The next step is to coat the inner surfaces and the ends of the bearings with acid, which is done by a small revolving brush, its underpart dipping into acid, Fig. 2. The caps are held by tongs that fit into the bolt holes, as in the babbitting in Fig. 3. By this method the work is quickly done and the acid is prevented from getting on the men and from being wasted. Only a small amount of acid is used. It is kept in the small wooden box shown, the tote-box beneath forming a sort of splash pan.

From the acid brush, the parts go to the Chadwick babbitting press (or machine) shown in Fig. 3. The caps are held by the tongs as shown. The babbitt is forced into place in the usual manner, so as to secure solid bearings. The construction of the upper part of the machine is clearly shown.

The babbitted bearings are then reamed on the Garvin duplex milling machine shown in Fig. 4. This machine was rebuilt for the purpose. The rod is located by a pin in the piston-pin hole, the pin being clamped in V-blocks. The end to be reamed is locked by various clamps, in which knife edges are used so as to avoid undue pressure that might tend to twist the rod.

With the rod locked in position, the bearing is rough reamed, the reamer being seen at *A*, and one end of

The ninth article. The tenth will appear in an early issue.

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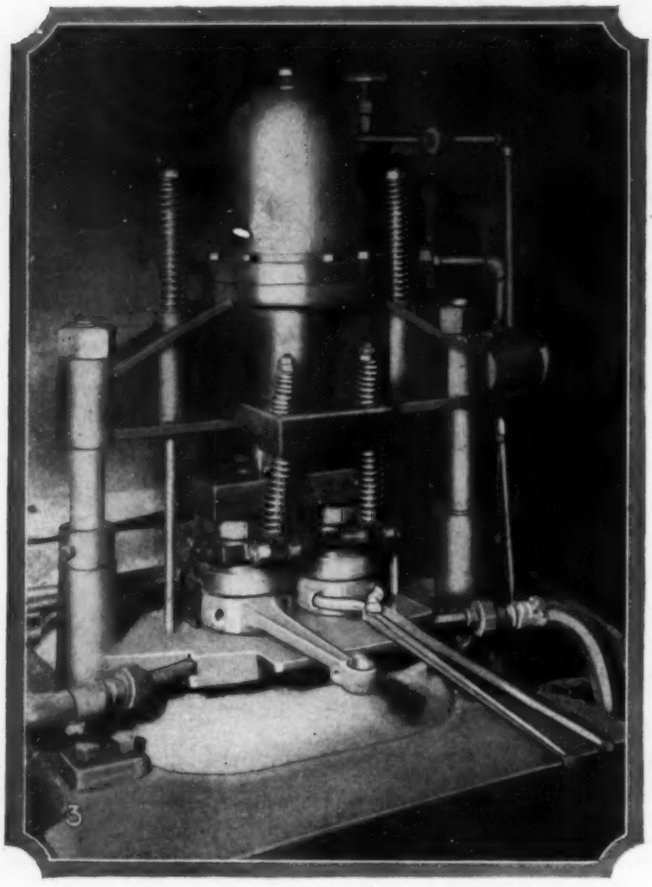
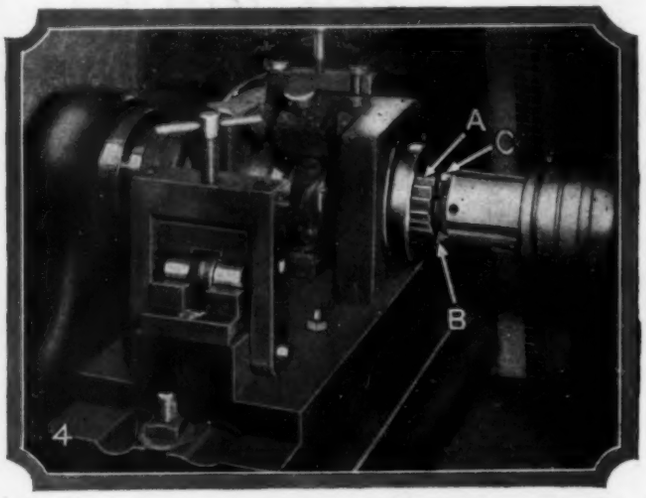




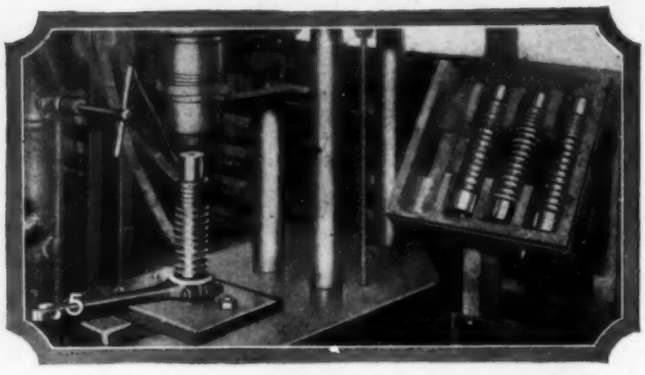
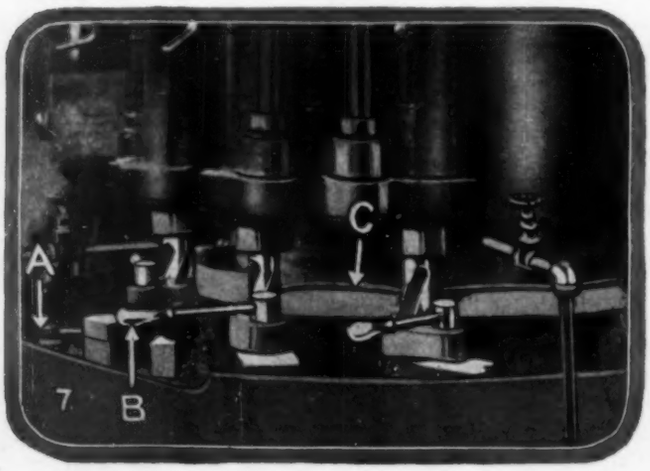


Fig. 3—Casting the bearing. Fig. 4—Reaming and facing. Fig. 5—Broaching the bearing

the bearing is faced and chamfered by cutters *B* and *C* respectively, and the spindle withdrawn. Then the opposite spindle advances, finish reams the bearing and faces and chamfers the other end. Details of the rod boring head are given in Fig. 6, the rod end being shown in position.

Following the reaming operation, the rod bearings are broached on the machine shown in Fig. 5. The first broach is shown in place, there being four in the set. They are kept in the box at the right when not in use. A close examination will show that the broaches have five burnishings rings at the top.

Connecting rods for the Oakland engine are first coined to insure uniformity in size, the small ends are drilled in the usual manner and the large ends are drilled in a special, Columbus drilling machine, Fig. 7.



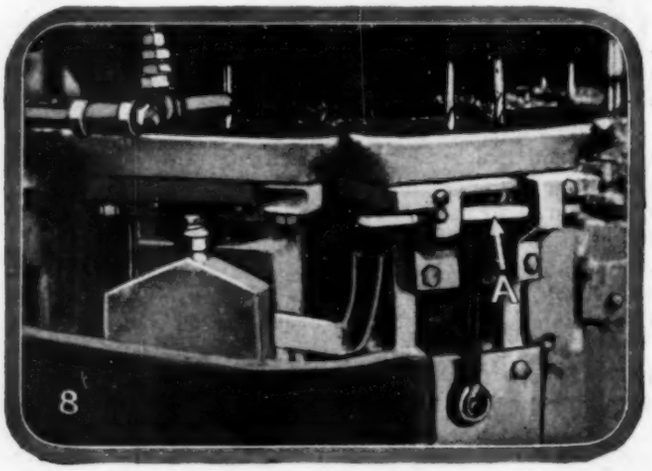


Fig. 7—Boring rods on special machines. Fig. 8—Drilling both rods and caps

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The rods are located by pins in the small holes as at *A*, and are clamped by levers as at *B*. The drills are guided in heavy bushings and are flooded with cutting compound that fills the circular trough *C* and flows to each drill. Machines of this type are not commonly found in this work.

Another operation that is out of the ordinary, is the drilling of either rods or caps on the same machine, after the caps have been cut off, as shown in Fig. 8. The fixtures are designed to take either caps or rods,

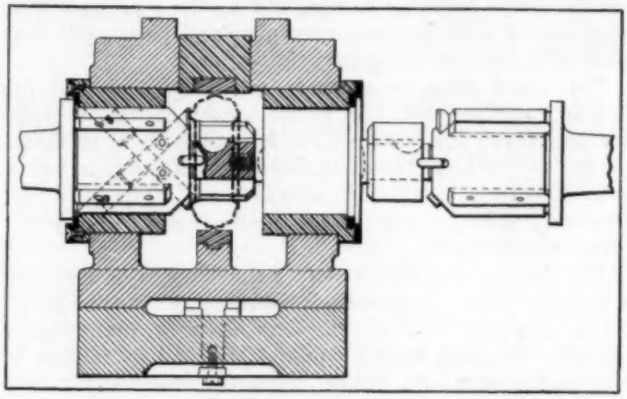


Fig. 6—Details of the reaming head

both being drilled and reamed in the same fixtures, insuring their going together easily in assembly. After locating them against the face of the fixture, wedges or keys, as at *A*, force them sideways and clamp them firmly in position.

The small ends are broached for the bushings, and the main bearings are die cast in place, after the surfaces have been thoroughly tinned.

Savings through Factory Standards

Some of the possibilities of savings in manufacturing costs due to an effective program of standardization and simplification are evident from the results of a brief investigation along this line conducted by a large manufacturer.

By reducing the stock sizes of steel and brass washers from 130 to 64 sizes a saving of about $3,000 a year in manufacturing costs and about the same amount in clerical expense was effected. Other extraordinary reductions in diversity were made: Several hundred cable cleats were reduced to nine; 750 punch fingers were cut to 75, with an annual saving of $7,000; and two other items involving reductions of 60 and 80 per cent respectively, each netted savings of $14,000 yearly. By cutting the variety of wood screws in half, over $4,000 was saved, although this plant is engaged in metal work. By eliminating 85 per cent of the files, a $7,000 saving was made possible. Similar savings were made on steel, brass and copper tubing, and on brass bars and sheets by cutting the variety in half. A somewhat greater saving was effected by standardizing office forms, although a reduction of only 20 per cent was made. The above figures were made available through the American Engineering Standards Committee.

Climbing Out of the Rut

BY ENTROPY

"Do you know the electrical business has it all over the machine tool trade?" So Jim greeted me when he got back from a vacation that was spent picking up pointers in other men's shops. "You see the electrical industry fell into the hands of highly technical men almost at the start. They had an idea that whatever was so could be figured out, and by gum, they have proved it. I wonder what would have happened to the machine business if the first men who made machinery decided to find out all the whys and wherefores before they began to build?

"You ask an electrical expert what size motor to use to drive anything and he asks you what temperature you are going to pump the molasses at, and how high above the sea level the boss holds his chin, and some more stuff, and then he tells you to use a 15-hp. motor, and that's all settled. Now let someone ask us machinery people what size shaper to buy to hog the metal off a lot of castings, and we size him up as to how big a bill he will stand and sell him the largest shaper that we think he will buy, and there is no danger that he will buy one that is too big. If anyone began to turn up half inch studs in my shop at 70 ft. per minute the reverse gears on his lathe would make so much noise that my stenog couldn't hear my dictation in the office.

"What we fellows ought to do is to throw away all the drawings, patterns, jigs and fixtures we have accumulated in the past hundred years and set a few bright young fellows who never saw the inside of a machine shop to design something that would be scientific. If it hadn't been for the automobile, you know, we would still be using cone head lathes. Somebody with a busted car left the transmission in the shop and some dumbbell thought it was part of a lathe and stuck it onto a headstock, and then we had geared-head lathes.

"No, sir, none of us old fellows ever changes the design of a lathe more than a sixteenth of an inch at a time. We don't dare to. Suppose when all 16-in. lathes had a head spindle 2 in. in diameter someone had brought out a lathe with a 3-in. spindle, could he have sold it? Not by a jugfull! Nor would he have widened the belt to three inches all in one jump. Not if there were any intervening widths on the market. Yes, sir! What we need is some one who will go to the root of the machine business and start something scientific."

In testing very hard metals by the Brinell method there is a tendency for the steel ball to flatten sufficiently to give an erroneous reading. It is also frequently difficult to measure the indentation owing to the smallness of the diameter. To overcome this difficulty some use a steel ball that has previously been etched for one minute in a solution of 2 per cent nitric acid in alcohol. The etched ball gives an impression in which the edges are more clearly defined, so that they are easier to measure.

Are Profit Ideals High Enough? —Discussion

By E. F. DuBrul

General Manager, National Machine Tool Builders' Association

EVER since I read the article on page 189, Vol. 65 of the *American Machinist*, I have been wanting to send in my comments for clarification of the subject. In the first place, I want to point out that the engineer in question made the same mistake that is made in every school arithmetic, in which the term profit is applied to the difference between cost and selling price, when the selling price exceeds the cost. What he really meant is better described by the term "gross margin," of which profit is only a part.

In this margin he specifically included administrative expense, financial expense, development costs such as experimentation, research, etc., new patterns and drawings. Some people want to put these into cost, but he specifically excluded them from conversion cost. He stated that unless 100 per cent of conversion cost were added, it was his experience that very few manufacturing industries could provide these things, and in addition, provide adequate reserves against the cost of cyclical idleness, adequate reserves for conservative expansion to keep up with the growth of the country, and adequate dividends for the stockholders, on top of these costs.

So with all these items to be provided out of this gross margin, I do not see why anybody should be stunned at all to find that all these things amount to at least as much as labor plus shop burden. I think that any successful machine tool company would probably find that they amount to more.

Another thing, he did not lay this 100 per cent out as an empirical cure-all formula. In fact, he specifically stated he thought it was a minimum, and that while most machine shops would have to get above that, he did not know how much above it they ought to get without investigating specific conditions.

Machinery Manufacturers Earn Less

Some of the commentators miss the point that the speaker was properly citing the fact that if profits are quite sufficient, we would not have so many failures, and we would not have such low income statements submitted by manufacturers as a class to the U. S. Treasury Department. Then, within the manufacturers' group, the Treasury statistics show that the machinery manufacturers as a class have earned less than the average of all manufacturers. This checks up with the statistics of failure published by the Commercial Agencies, which show the machine industries to run very high in the failure rate, compared to other manufacturing industries. If profit ideals are high enough, why is it that the failure and income history runs contrary to high profits, and shows low profits?

Now, to comment on the statements in the order in which they appeared. The first man sets out the experience of four plants. He mentions that there are certain differences as between the product of these different plants, and he brings out a different percentage of conversion cost in each case.

The data are not complete. First, is he satisfied with the selling price of the product of Plant A, and does that selling price produce as good a return on the investment as the selling price of Plant D? I think this commentator takes the original statement in a wrong light, as an empirical formula when it was not intended as such in any way.

The second man assumes a standardization of cost determination that does not exist. He also pointed out the desirability of each industry safeguarding its future welfare by adding an adequate margin of profit. The speaker was trying to get his hearers to see this very necessity, and, merely as a guide to what they would discover, he told them that he did not think they would find they got an adequate margin if their price was less than material plus conversion cost, plus 100 per cent of conversion cost. He does not propose that men should guess at these things, but he does propose that they should analyze them carefully, and points out that they will discover some surprising facts.

The third man, in common with the first and the second, admits that the profit ideals of the average manufacturer are too low, but he wants them to figure profits on the total cost, because he thinks that is better than shooting at the conversion cost. The point is, however, that he admits the main thesis, that profit ideals are too low.

The fourth man also mistakes the suggestion as being a definite rule. He does not seem to think that profit ideals are too low, but lays failures to many other things. He says rarely would it be due to failure to add sufficient profit. Now, whatever the contributory causes are, the final wind-up is that failure comes from not getting sufficient profit.

The fifth man takes the view that prices should be high enough so that the stock should pay 7 per cent to enable the company to secure additional capital at a reasonable cost. This man seems to act on the assumption that par value of stock means something. What about stocks that have no par value? What about concerns that have a large book surplus? What about stocks that have good-will values capitalized?

The sixth man denies that profit ideals are too low, but says that economic laws wreck the ideal. He seems to think that the action of so-called economic laws is as extraneous and far removed from a human being as is the law of gravity. He forgets that so-called economic laws do not work except as men make them work. Somebody puts up a price, or puts it down. That does not happen automatically apart from a human will. So, when somebody puts prices too low, and thereby wrecks the sound profit ideals of somebody else, it seems to me that the profit wrecker had too low a profit ideal.

The seventh man admits that profit ideals are too low, and lays it to men of ignorance who do not make sufficient allowance for overhead. He indulges in the glittering generality of adding a fair profit to a given figure, but I wonder what he does when his competitor does not add what No. 7 considers to be a fair profit. If there are enough inexperienced managers, they can wreck the profit ideals of all the experienced ones.

I hope that more discussion will come out of this, and that it will show a clearer conception of just what should constitute a sound profit theory. I think that if they analyze the thing clearly, the successful machinery building companies will find that, in the past, they must have been operating on a gross margin of more than 100 per cent of conversion cost, or they could not have become successful.

Reclaiming Journal Bearings at the Great Northern Shops

By Frank W. Curtis
Western Editor, *American Machinist*

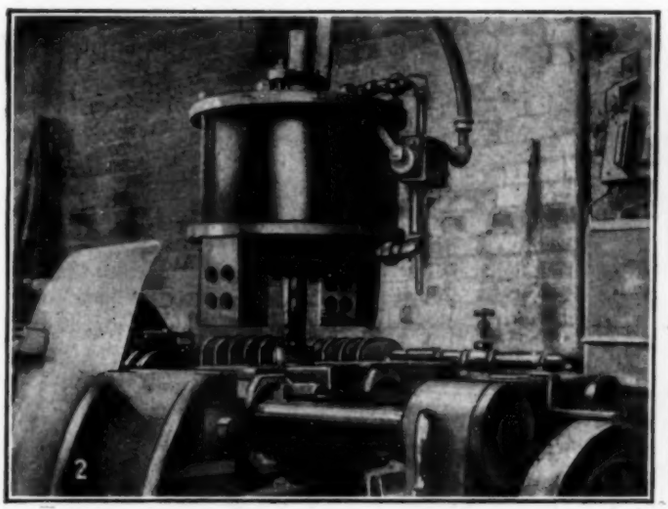
Furnace for melting worn linings and reclaiming the old bearing metal—Boring, facing and relining brasses—Relined brasses are finished by milling

THE salvaging of journal bearings used on locomotive tenders, passenger and freight cars is one of the few strictly production problems encountered in the locomotive repair shop. When the amount of rolling stock of a railroad is taken into consideration, and when it is realized that from four to sixteen bearings are used on each unit, an idea of the quantity of work to be handled can be visualized. Realizing the need of standardization in this branch of work, the American Railway Association, in 1920, adopted a practice applicable to axles, boxes, journals and their contained parts. The recommended practice for journal bearings, commonly called car brasses, covers specifications such as general dimensions, permissible variations, and finish required, chemical analysis of brasses and linings, and an outline of inspection requirements.

To fulfill these recommendations and to meet its requirements, the Great Northern Railway Co., in its St. Paul shops, has developed a department for reclaiming journal bearings. When the worn bearings are received they are weighed and then piled beside a melting furnace, regardless of their size or condition. The first operation is melting the worn lining from the brass, and in Fig. 1 is illustrated the furnace used, in which the journals are fed through in two rows. After a pair of journals has been placed on the projecting platform, and a proper time allowance made for melting the work already in the furnace, the operator manipulates a lever at the right-hand side of the furnace, which controls an air-operated feeding attachment. The device consists of an air cylinder, connected through a plunger to the plate *A*. Each stroke moves the plate a distance sufficient to carry two bearings into the furnace. The steel floor of the furnace is perforated, so that the molten lining metal can pass through it. Underneath is a metal drip pan so placed that the metal it catches will run out of the spout at the left-hand side of the furnace. The temperature of the furnace is held at 650 to 750 deg. F. which is sufficient to melt the lining and yet not affect the brasses. Approximately 15 tons of brasses are passed through the furnace in 8 hours.

The molten lining passes into the molds *B*, mounted on a truck as shown. The truck is on a track, and when one mold has been filled, the operator moves the truck so that an empty mold is brought under the spout. At the opposite end of the furnace the brasses are ejected into a pan. While still hot, an inspection is made of each brass to determine whether it is suitable for further use. Rejected brasses are melted and recast. A percentage of new brass is mixed with the salvaged material, so that a proper mixture is obtained. Brasses that can be re-used are tinned and relined as will be shown later.

New brasses are bored and faced in the Newton, car-



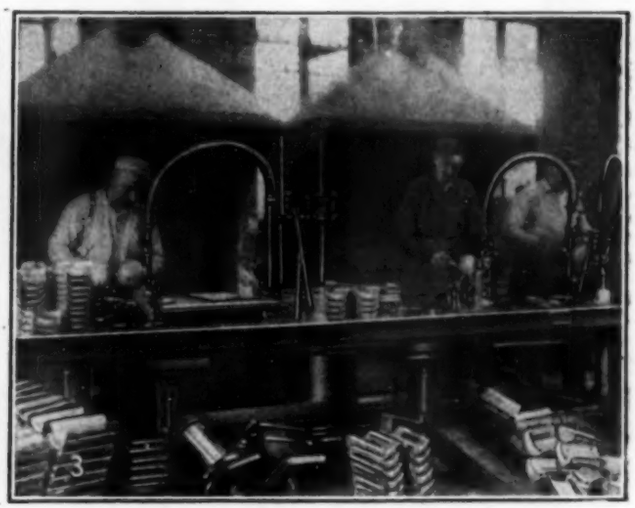


Fig. 2—Boring and facing brasses. Fig. 3—Relining brasses

Fig. 1—Furnace used for reclaiming lining metal

brass boring machine shown in Fig. 2, in which a home-made, air-operated clamping device is used. The piston and piston rod, fastened to the carriage, remain stationary while the cylinder moves vertically. On the cylinder are mounted two clamping blocks, arranged so that they strike the work and clamp it when the cylinder is lowered. Two pairs of brasses are machined at one setting. The machine is equipped with a rapid-traverse mechanism, operated by a friction clutch, to reduce the time of returning the carriage to the starting position. Stellite tools, set in adjustable holders are used for boring and facing. The depth of the cut is approximately ⅛-in., and the life of the tools averages 125 pieces per grind. Two pairs of brasses are machined in 3½-min., floor-to-floor, and two machines are used, although they are not both kept in constant service.

The relining of brasses is handled by three men, as shown in Fig. 3. Both new brasses and those reclaimed after having their worn linings removed, are handled similarly. The brasses are preheated and acid is brushed on the surface to which the lining is to be applied, then they are tinned in accordance with standard practice. The tinned brass is clamped to a babbitting fixture and the babbitt is poured from a ladle by hand. The center portion or arbor of the fixture is made hollow so that water can be passed through it to help cool the lining and thereby permit the earlier removal of the brass. Melting pots for the tin and the babbitt metal are in furnaces behind the operators. Each operator relines an average of 180 brasses per day of 8 hr. This time includes a visual inspection of the work.

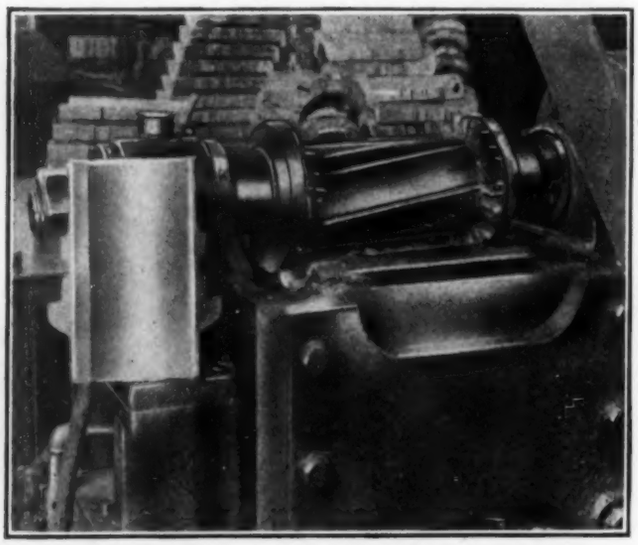


Fig. 4—Finishing the bearing surfaces

The final operation, that of finishing the bearing surface, is handled in the Morton journal-bearing miller, illustrated in Fig. 4. The operation consists of straddle milling to length, milling the lining and the fillet on one end. A bearing is placed in jaws in a vertical plunger, then the operating lever of the machine is actuated. The jaws are closed automatically and the plunger is fed upward, causing the work to enter the path of the cutters. Both movements are air operated, that of the last mentioned being arranged so that the work advances rapidly to the cutters and then feeds gradually while the cut is being taken, until a predetermined stop is reached. The cutters have inserted blades, and inasmuch as the metal being machined is soft, their life is comparatively long. The production is 100 pieces per hr. A finished bearing is shown standing on the left side of the machine. A final inspection is made of each bearing in which all important dimensions are carefully checked for accuracy.

Prolonging the Lives of Cutters Between Grinds

BY DONALD A. HAMPSON

No matter how good equipment is when newly bought, it is an undeniable fact that the stress of high production causes a certain let-down that has to be accepted as the average operating condition. Consider the degree of accuracy in milling cutters and arbors when working under load.

Cutters that are carefully sharpened, arbors that run true, and collars that have parallel ends, should be commercially proof against "running out" when the gang is set to work—but, an examination of the great majority of cutters sent to the grinder will show that not more than half of the teeth are really dull. In other words one-half of the teeth are doing all the work, and because of this the machine has to be taken down just twice as often.

Realizing this condition, rather than ignoring it, a shop that runs some fifty millers has adopted an easy method of saving a part of this lost time. All the arbors have a second keyseat cut in them, half way around from the original one. Then, when the cutters on any job show a dullness, the arbor nut is taken off, the key pulled out and placed in the opposite keyway. The cutters are turned 180 deg. and tightened in place. The collars are left as they were—all the collars have two clearance keyseats through them and, as a further aid in putting them back where they were, the workman strikes a chalk line across them before loosening them.

This simple change presents the sharp part of the dulled cutters to the work and is done very quickly. It is not guaranteed, nor is it expected, to automatically bring the sharp side to work but it has been found to do so in most cases, and to be a big time saver.

Abstracts of Steel Treaters' Papers

These papers were presented September 20-24 at the Chicago meeting of the American Society for Steel Treating

Studies on Electric Welding

By Ludwig J. Weber
Instructor in Metallography, University of Minnesota

THIS paper is the first of a series on electric welding and covers the effect of the various atmospheres on electric welding. In order to carry out electric welding tests in an atmosphere of known composition it was necessary to design and construct special apparatus for that purpose. The apparatus consisted essentially of a bell jar, in which the welding was done, standing on a pedestal immersed in water so that the mouth of the bell jar was below the level of the water in the tank. The specimen to be welded was bolted on to a well-insulated copper cable and was made the positive pole. It consisted of boiler plate about ½ in. thick, 4 in. long and 1 in. wide, into which a 90-deg. V-shaped groove had been cut with a milling cutter. The electric current was obtained from a motor generator. The current used during the welding varied from 60 to 80 volts and from 100 to 150 amperes.

In filling the container with the desired gas, the specimen was first clamped in position. The air was then pumped out by means of a vacuum pump which filled the container with water. The gas was then put into the container either through the outlet on top or else through the bottom by the downward displacement of the water. The expansion of the gas in the jar, due to the heat given off by the arc, was quite large and the welding had to be interrupted frequently in order to permit the gas to cool. If this were not done, the pressure would finally become so great that the gas would be lost from the container. This made it impossible to make good welds but gave the effects of the gases on the deposited metal as well as the effect of the arc on the gases, both of which were desired.

In analyzing the gases both before and after welding, the sample was obtained by connecting the outlet with an Orsat apparatus using ordinary precautions not to admit any air with the gas. The gas was analyzed for carbon dioxide, oxygen and carbon monoxide by absorption in potassium hydroxide, pyrogallol, and acid cuprous chloride, respectively. Check analyses were made on each sample. The unabsorbed gas was not further analyzed due to the fact that proper apparatus was not available. In most cases it would be nitrogen, although there is a possibility of some other gas being formed during the welding, which would not be removed by the above reagents and thus be reported as nitrogen.

The carbon dioxide was obtained from a cylinder of commercial gas and had the following analysis: carbon dioxide, 97.5 per cent; oxygen, 0.5 per cent, carbon monoxide, 0 per cent, and nitrogen, by difference, 2.0 per cent. After the welding tests, the gas had the following analysis: carbon dioxide 86.4 per cent; oxygen, 0.6 per cent; carbon monoxide, 8.3 per cent, and nitrogen, by difference, 4.7 per cent. The arc was easier to maintain in this atmosphere than in the case of welding in air. After welding, the sides of the jar were covered with a brownish black soot which was magnetic and dissolved in hydrochloric acid. The deposit was not further analyzed but was probably similar to that described later under the tests in carbon monoxide.

The decomposition of the carbon dioxide may be expressed by the equation:

$$2CO_2 \longrightarrow 2CO + O_2$$

This should give an increase in oxygen equal to one-half of the increase in carbon monoxide. The analyses, however, show that the oxygen content remained about the same. After welding, the water was covered with a film of red oxide which indicated that the liberated oxygen combined with the iron to form the oxide and thus did not show an increase on analysis as should have been the case according to the above equation. The complete reaction may be indicated by the following equation:

$$3CO_2 + 2Fe \longrightarrow 3CO + Fe_2O_3$$

In examining the structure of the steel as deposited in welding, irregular patches of pearlite could be seen on the ground mass of ferrite. Round black patches, either slag or blowholes, were also visible. The same specimen was then carburized in a well-known carburizing compound for six hours at 1,650 deg. F. and then cooled in the furnace in the carburizing box as recommended in the McQuaid-Ehn test. The structure consisted of very coarse lamellar pearlite with excess of both cementite and ferrite. It was also noted that all slag particles or blowholes were on the boundary of the cementite or entirely surrounded by it. This condition was found throughout the specimen.

The results show that oxidation of the iron occurs while welding in a carbon dioxide atmosphere with the formation of carbon monoxide gas. If we compare the gas analysis with that obtained while welding in a carbon monoxide atmosphere, it is noticed that in both cases the nitrogen obtained by difference increases more than should be, due to experimental error. The probable cause for this increase is given in the discussion of the results obtained in a carbon monoxide atmosphere. The reason the increase in nitrogen is less in the case of carbon dioxide atmosphere is most likely that the concentration of the carbon monoxide was much lower and therefore less of the iron-carbon monoxide compound would be formed.

When photomicrographs of the material deposited in the carbon dioxide and carbon monoxide atmospheres and then carburized, were examined, both of them showed themselves to be abnormal carburizing steels. In the case of the material deposited in the carbon dioxide atmosphere there is still a tendency to form lamellar pearlite, while in the case of material deposited in the carbon monoxide atmosphere there is no indication of any lamellar pearlite. This may again be explained by assuming that the concentration of the substance causing this abnormal carburizing was greater in the material deposited in the carbon monoxide.

Carbon monoxide was prepared by allowing formic acid to drop into a flask containing concentrated sulphuric acid. The gas generated was passed through a solution of potassium hydroxide to absorb any carbon dioxide that might have been formed and then was collected in the bell jar by downward displacement of the water. The analysis of the original gas was as follows: carbon dioxide, 0.2 per cent; oxygen, 0.2 per cent; carbon monoxide, 98.2 per cent; nitrogen, by difference, 1.4 per cent. After welding, the analysis of the gas was: carbon dioxide, 3.8 per cent; oxygen, 0.4 per cent; carbon monoxide, 90.0 per cent; nitrogen, by difference, 5.8 per cent. The arc could be maintained more readily than in the case where a carbon dioxide atmosphere was used but not as easily as with the nitrogen atmosphere. The jar was covered with a brownish soot similar to that obtained when welding in carbon dioxide but in greater quantities.

The gas analysis indicates that carbon monoxide is not stable during the welding process. Due to the fact that some of the iron is at such a high temperature, the following reactions may occur:

$$6Fe + 2CO \longrightarrow 2Fe_2C + O_2$$

$$2CO + O_2 \longrightarrow 2CO_2$$

$$\left\{\begin{matrix} 2Fe + O_2 \longrightarrow 2FeO \\ 3Fe + 2O_2 \longrightarrow Fe_3O_4 \end{matrix}\right\}$$

The per cent of unabsorbed gas which is reported as nitrogen increased to a greater extent than could have been due to the concentration of nitrogen. This increase could not be attributed to experimental error because the analyses were checked with good agreement. It appears that these results are best explained by assuming the formation of iron carbonyls which do not condense and which are not absorbed by the reagents used in the gas analysis. The presence of these compounds, however, has not been definitely established. The soot on the sides of the container was analyzed and contained 51.9 per cent iron. A black material similar to graphite separated out of the substance when it was digested with 1:1 hydrochloric acid. This analysis suggests the formula $Fe(CO)_2$ which contains 50 per cent iron.

The microstructure of the metal consisted of a mixture of ferrite and cementite with blowholes and slag particles. No increase in carbon content could be noticed. After heating the material at 1,650 deg. F. for fifteen min. and then cooling in the furnace the photomicrographs showed that the carbide was in the form of needles and not as pearlite which would be the structure ordinarily obtained from this heat-treatment. When the material was carburized according to the McQuaid-Ehn test, only areas of cementite and ferrite, with no pearlitic structure, were to be observed. Nearly all the slag or blowholes were inclosed in the cementite areas.

The results show that oxidation and carburization of the iron may occur while welding in a carbon monoxide atmosphere. The gas analysis indicates that some gaseous compound is formed which is not absorbed by the reagents used in the ordinary gas analysis. This would, of course, increase the apparent per cent of nitrogen which was obtained by difference. This large increase in nitrogen could not be satisfactorily explained in any other way.

Prevents Pearlite Formation

The material deposited in the carbon monoxide atmosphere has some substance which has a great effect on the way in which the carbide separates from the austenite or solid solution. On annealing even a low-carbon steel, the carbide will not separate out in a pearlitic structure but as carbide needles, which indicates that this substance is active in preventing the formation of lamellar pearlite. After carburizing, this great effect on the precipitation of the carbide still remains as no pearlite is present in the carburized piece, the structure of which consists of cementite and ferrite.

The analysis of the material on the sides of the jar indicates that a compound $Fe(CO)_2$ might have been formed. This compound has not yet been reported in the literature and further work would have to be done in order to substantiate this conclusion.

The nitrogen atmosphere was obtained from a cylinder of commercial gas and had the following analysis: carbon dioxide, 0 per cent; oxygen, 0.6 per cent; carbon monoxide, 0 per cent; nitrogen, by difference, 99.4 per cent. After the welding tests the gas had the following composition: carbon dioxide, 0.4 per cent; oxygen, 0.1 per cent; carbon monoxide, 0 per cent; nitrogen, by difference, 99.5 per cent.

The arc could be maintained much more readily than in the case when carbon monoxide or carbon dioxide atmospheres were used. A soot covered the sides of the jar the same as when the other two atmospheres were used but on rough estimation there was a heavier deposit in the case of the nitrogen atmosphere. An analysis of this soot showed that it contained 90.3 per cent iron. It was not analyzed for any other elements due to the small amount of the sample that was available. The iron content, however, suggests the compound Fe_4N_2 which contains 90.9 per cent iron and has been reported in the literature. The gas analyses show that some of the carbon in the steel was oxidized to carbon dioxide while a small amount of the oxygen most likely combined with the iron to form the oxide.

Cementite or nitride particles could be seen distributed throughout the material. The small round particles indicative of either slag or blowholes were found, by careful focusing, to be in most cases holes. When the material was heated and cooled, pearlite areas and nitride needles could be readily distinguished. The nitride, similar to cementite, is not attacked by picric acid. The nitride, however, is found as needles in areas of ferrite whereas the cementite generally collects in areas of pearlite. As yet no suitable etching reagent is known to distinguish between needles of these micro-constituents.

When the material was carburized as in previous

cases, the structure showed small areas of pearlite and excess of ferrite and cementite. The characteristic nitride needles could not be seen.

The results of these experiments show that the iron combines quite readily with nitrogen at the temperature of the electric arc. In the low-carbon steels, the nitride appears as needles in the ferrite, similar to results obtained by other investigators. The nitride seems to have great effect on the way in which the carbide will precipitate out. In low-carbon steels it does not prevent the formation of pearlite, but in high-carbon steels obtained by carburizing, it causes the cementite to precipitate in large masses instead of in the pearlitic structure.

In making welds in air it was impossible to inclose the specimen in the glass jar and then make the weld as was done in the previous experiments. This was due to the fact that the iron would combine rapidly with the oxygen present which would cause the water to rise in the container and finally cover the specimen to be welded. The weld was made with commercial apparatus and ⅛-in. rod containing below 0.1 per cent carbon.

The structure of the deposited material could be seen to consist of material etching similar to cementite distributed as small particles throughout the ferrite. The usual small particles were found in most cases to be slag inclusions. When the material was heated and then cooled the structure in the weld could be seen to consist of cementite pearlite and nitride needles similar to those obtained when welding in a nitrogen atmosphere. When the material was carburized, the boundary between the weld and the specimen could easily be recognized. The structure in the deposited material showed large globules of cementite with hardly any pearlite, which structure is characteristic of abnormal carburizing steels.

The helium was obtained from the Bureau of Mines and, according to their analysis, contained about 6 per cent nitrogen, the remainder being helium. In making the welds in this atmosphere it was noticed that at first the arc was fairly easy to maintain but after several rods had been deposited it became more difficult. On examining the material deposited it was noticed that the first part of the weld gave very abnormal structure on carburizing while the last portion deposited gave a more nearly normal structure but still was not entirely normal.

In order to obtain the helium free from nitrogen, magnesium wire was heated in the container by means of the electric current. The magnesium combined with the nitrogen leaving the pure helium. After the helium had been purified, a weld was made in this gas. The structure of the material deposited consisted of pearlite, a few particles of cementite, and ferrite. Blowholes were visible. When the material had been carburized, the structure obtained at 100 magnification showed pearlite with the excess cementite around the grain boundaries, which is characteristic of normal steels. At 1,000 magnification it could be seen that lamellar pearlite was present with the excess cementite on the grain boundary.

The results from these tests show that normal carburizing steels can be produced by welding, providing an inert atmosphere surrounds the material during the welding process. The tests also confirm the results obtained in welding in a nitrogen atmosphere as the nitrogen in the helium caused abnormal carburizing steel and it was only after the removal of the nitrogen that normal steel was obtained.

The Nature of Oil-Hardening Non-Deforming Tool Steels

By Edgar C. Bain* and Marcus A. Grossmann†

THE present paper deals with some fundamental characteristics of a type of tool steel known generally as "oil-hardening, non-shrinking steel or non-deforming steel." Such steels contain only a small amount of alloy sufficient to permit the more gentle oil-quench to be substituted for the drastic water-quench demanded by carbon steel. Oil quenching causes fewer cracks and the hardening is deeper than in carbon steel hardened in water.

The steels under consideration are useful in gages of various types and in master gages but they will not stand up under severe service.

The persistence of austenite and the manner of its decomposition, as much as any other single property, provide an index of the ultimate nature of the steel. The particular grade of tool steel here discussed is exemplified by two different compositions which are, in general, maintained as shown in the accompanying table. The No. 1 steel depends on manganese for developing the oil-hardening qualities, while steel No. 2 is to a moderate extent a chromium steel, the chromium in this case facilitating the formation of martensite with the more gentle quench.

Although the amount of alloy is small the scale formed is much thinner than usual. It is probably true that in simple shapes the slight expansion of the metal itself in hardening is about equal to the thickness of the scale so that when the scale is polished off the piece will be approximately the original size. The result is a saving in grinding and polishing.

Variation in quenching temperature has but a slight effect upon the hardness of steel No. 1 when it is quenched in oil. As soon as the piece has been heated sufficiently above the critical temperature to render it wholly austenitic and to produce a sufficiently high cooling rate through this critical temperature in the oil bath, then a hardness is established which cannot be greatly increased by heating to a higher temperature. The conclusion is that the hardness of the martensite-austenite mixtures in this particular steel is not greatly affected by change in the proportion of the two constituents.

The grain of the steel remains quite fine even in the specimens quenched from 1,650 deg. F. The curves for the effect of the drawing temperature on the hardness

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are remarkably similar and show more or less uniformly decreasing hardness with the increase of the drawing temperature. The hardness measurements were made on manganese steel but several isolated hardness measurements on the chromium steel, No. 2, not sufficiently numerous to be regarded as a series, checked the hardness values of the No. 1 steel closely. The tests were made on the Rockwell hardness tester.

For the length change study, cylindrical specimens were employed. The cylinders were about 2½ in. long and 1½ in. in diameter. Protective caps to prevent oxidation were bolted on to the specimens and even after the highest quenches, when the caps were removed, the ends of the cylinders presented an essentially untarnished surface. The two alloys showed a

Composition of Tool Steels Investigated

	Steel No. 1	Steel No. 2
Carbon	0.85–0.95	0.85–0.95
Manganese	1.50–1.75	1.00–1.20
Phosphorous	Less than 0.020	Less than 0.020
Sulphur	Less than 0.020	Less than 0.020
Silicon	0.10–0.20	0.10–0.20
Chromium	None	0.40–0.55

close similarity in the curve following the length changes. A sharp minimum of length is obtained at about 400 deg. F. and a marked maximum in length is produced by reheating to a temperature only 100 deg. higher or 500 deg. F. The characteristic expansions and contractions of the two steels occur at precisely the same temperatures regardless of the quenching temperatures.

The 2½-in. cylinders expanded with high-quench between 0.004 and 0.005 in. and with the ordinary quench between 0.001 and 0.0015 in. That is to say, the linear expansion upon the quench ranges from 0.06 per cent to 0.20 per cent, depending upon the temperature of the quench between 1,450 deg. F. and 1,750 deg. F. The pieces quenched at 1,450 deg. F. are probably hardened only part way through, so that the expansions and contractions take place only in an outer layer. The unhardened center would have a restraining effect on the motion of this outer layer so that the total expansions would be decreased. For both grades of steel the expansion at 500 deg. F. drawing temperature restores the steel almost exactly to the length acquired as a result of the quench. Since the steels are used frequently for gages a study was made of the effect of variously threaded surfaces upon the change in cylinders of the same size. The results showed little change with 8, 16, and 24 60-deg. threads per in., which were the threads tested.

Structural Changes

So far as is known the only structural change in steels of this character which can account for an expansion upon reheating is the change of austenite to alpha iron. We have then almost uncontrovertible evidence that in these low alloy steels a very considerable amount of austenite is retained after the quench and that it is quite persistent up to 400 deg. F. Up to that temperature it is apparently stable, and is then released, sharply and quite completely, slightly above this temperature as evidenced by the fact that up to a temperature of 500 deg. F. there is a very steep slope of the expansion curve.

Evidence is quite clear that the martensite of such steels is progressively decomposed into troostite, sorbite, etc., more and more rapidly as the steel is reheated to temperatures above 200 deg. F. Remembering the extremely rapid contraction which follows the austenite-alpha iron transformation at 500 deg. F., we are able with assurance to point to these types as examples of steels wherein a generous preservation of austenite is entirely incapable of producing secondary hardness by drawing back to break down the austenite. This is shown by the fact that the hardness decreases gradually and regularly. There are none of the variations which usually accompany the observed increases and decreases in dimensions and impact toughness. In fact, it may well be suggested that the austenite preserved after the quench transforms directly into troostite or into a very transient form of martensite. At any rate, we are certain that whatever contribution to hardness is offered by the release of austenite at 500 deg. F., this contribution is not more than sufficient to make up for the rapid loss in hardness accompanying the decomposition of the martensite produced at the time of the quench.

The changes from brittleness to toughness in steels are in general so sensitive that the measurements of impact strength might be expected to cast some light upon what takes place structurally during the reheating of these alloys. Accordingly groups of five or six identically treated specimens were made up and broken —each group representative of one of a number of reheating temperatures, all having been quenched from 1,425 deg. F., in oil.

Measuring Impact Strength

On account of the susceptibility of impact strength measurements to the slight surface imperfections and other differences beyond the control of the heat-treater, it has always seemed advisable to have a number of values for a single point which may be averaged in order to reduce experimental error. The impact values used were obtained from a ⅜-in. square unnotched bar on a Charpy machine. The departure of the individual readings from the reported mean is satisfactorily small. As might have been expected the impact strength is at a maximum at about 450 deg. F., a temperature corresponding quite closely with the greatest preliminary shrinkage. The impact value falls off rapidly with a higher reheating temperature corresponding to the range of the destruction of ductile austenite.

Reheating of the steel to higher temperatures causes a very rapid and enormous increase in impact strength, corresponding approximately to the condition of annealed steel. The impact maximum at 450 deg. F. and the impact maximum at 550 deg. F. both occur at a temperature about 50 deg. higher than that observed on the length change charts for what is believed to be the same condition in steel. The explanation of the 50-deg. discrepancy may be found, doubtless, in the circumstance that the length change measurements must of necessity always be measured on the same bars successively reheated—the drawing effect being cumulative—whereas obviously the impact specimens have had but the single reheating. The time of holding the specimens at any given temperature was half an hour in each case.

The authors find a rather disturbing condition at the 550-deg. point which appears to be a very critical one for impact value. Regardless of the care to insure

perfect duplication with which twelve specimens are heat-treated, there is always considerable disparity in the impact for this particular drawing temperature. The values obtained may be grouped quite easily into two classes, high and low. This appeared to be a very discouraging circumstance, but it can probably be explained by the extremely unstable nature of the martensite produced by the decomposition of preserved austenite. If it remains as martensite, it will contribute greatly to brittleness, but in all probability at this relatively high temperature, the martensite is scarcely formed until it decomposes into the tougher troostite. In the realm of heat-treatment, experimental accuracy is scarcely great enough to obtain any large number of specimens in just the condition to show the brittleness of martensite. A few specimens will have continued the sequence of changes far enough to achieve a considerable impact value. Whether or not this is the correct explanation for the vagaries of the impact tests at 550 deg. F., it does at least conform with the idea of the ephemeral nature of martensite produced by the decomposition of austenite in these steels.

Conclusions:

(1) The addition of a small amount of alloy (e.g., 1½ per cent manganese or 1 per cent manganese with about ½ per cent chromium) causes the steel to harden deeply with the mild oil quench. The hardness is not modified materially by the quenching temperature employed.

(2) These steels are softened by drawing back in much the same manner as carbon steels—irrespective of quenching temperature there is no secondary hardness to be observed.

(3) Austenite is retained copiously in the steels when oil-quenched, the amount increasing with the temperature.

(4) The austenite of this class of steels is decomposed at about 450 deg. F. in the course of 30 to 45 minutes.

(5) The dimensions of these steels—as, for instance, in carefully made precision pieces—varies markedly with the drawing temperature and without sacrificing hardness a proper drawing temperature can usually be applied so that the final size—cleaned of scale—is very near that of the original work.

Fatigue Strength of Hard Steels and Their Relation to Tensile Strength

By J. M. Lessells*

IT IS well known that the tensile test does not give complete information on the characteristics of material subjected to alternating stresses and when such conditions exist it is also necessary to obtain fatigue values of the material if safe and economical working stresses are to be the result. However, it may be impracticable in all cases to obtain such data and the question of the relation of such to the tensile test values is of great practical importance.

It is generally accepted that the relationship between Brinell hardness numbers and tensile strength is fairly constant for steels which have a hardness number less than about 300. Data from the 1920 report of the steel research committee of the Institution of Automobile Engineers indicate that the relationship is $P = 486H$, where P is the tensile strength in pounds per square inch and H is the Brinell hardness number. The relationship appears to hold only for steels in well tempered conditions. While this is difficult to explain it may be that any departure from the relationship may be caused by residual stresses present in the steel. For instance the values for the 0.1 per cent carbon, a steel not affected by heat-treatment, are in a constant relationship, whereas those of the 1.50 per cent nickel, and 3 per cent nickel—0.8 per cent chromium are high for the condition as quenched but again are normal when tempered. The values for the 0.20 per cent carbon and 0.35 per cent carbon steels are below the normal for the condition as quenched but again normal when tempered.

Values for a 3.5 per cent nickel steel and a 4.5 per cent nickel—1.5 per cent chromium are given by Gough. His data include corresponding figures on the relation of endurance limit to tensile strength. His data indicate that in some cases the relationship between tensile strength and hardness number is good when the steels have been sufficiently tempered but give high values of hardness when this is above 400, approximately.

These results led the writer to carry out certain tensile and fatigue tests on very hard steels to see if further light could be thrown on this subject. For this purpose two steels were chosen, a 0.42 per cent carbon and a 1.0 per cent carbon. These were then heat-treated and ground to finished dimensions. The treatment given was as stated below, the 0.42 per cent carbon steel being designated as steel "A" and steel "B" being the high-carbon steel.

Table I—Tensile Test Results

Steel	Treatment	Prop. Limit Lb./Sq.In.	Ult. Stress Lb./Sq.In.	Elong. on 2 in. Per Cent	Red. of Area Per Cent	Brin. No.
A	1	31,000	212,000	2.0	5.5	578
A	1	40,000	249,000	1.6	4.7	578
A	2	35,000	215,000	7.0	41.6	477
A	2	.....	215,000	6.7	32.8	477
B	1	122,000	240,000	3.7	9.3	495
B	1	118,000	242,000	8.5	13.0	495

Steel A—Treatment No. 1. Normalized at 1,580 deg. F., quenched in salt solution X at 1,562 deg. F., and drawn at 210 deg. F. for one hour.

Steel A—Treatment No. 2. Normalized at 1,580 deg. F., quenched in salt solution Y at 1,435 deg. F., and drawn at 590 deg. F. for one-half hour.

Steel B—Treatment No. 1. Normalized at 1,520 deg. F., quenched in lime salt solution at 1,472 deg. F. and drawn at 570 deg. F.

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In these tests considerable difficulty was experienced. Using the standard A.S.T.M. test bar, fracture took place in the grips and it was necessary to redesign the test bar so that the ends were 1 in. in diam., while the central portion was 0.505 in. in diam., with a 2-in. gage length. For the determination of the proportional limit a Marten's mirror extensometer was used to increase the accuracy of the test. The Brinell hardness tests were made on the ends of the tensile test bars, using specially hard balls. In the fatigue tests the cantilever form of test bar was employed. Considerable difficulty was again experienced in order to get satisfactory results and the diameter of the small tapered end of the test bar had to be increased. Tables I and II give the complete data for all the tests made.

Table II—Fatigue Test Results

Steel	Treatment	Endurance Limit Lb./Sq.In. for complete stress reversal.
A.....	1	81,000
A.....	2	98,000
B.....	1	112,000

The tensile and hardness values as obtained on these steels showed that steel B-1 was in good agreement with the previously mentioned law. Steel A-1 was in very apparent disagreement, while steel A-2 was more nearly normal. These results led to making some measurements in order to determine if residual stresses were present. It was established that the following compressive residual stresses were present in the outside: Steel A-1, 110,000 lb. per sq.in.; steel A-2, 30,000 lb. per sq.in.; steel B-1, 0 lb. per sq.inch.

It is not contended that these residual stress values are any more than an indication of what is present in the material and that they are strictly comparable with the discrepancy shown by the previous law of constant relationship. The test bar form itself will have an influence on these results. They do confirm, however, that when there is a departure from the normal, residual stresses are present.

If there is a departure from the normal relationship for hardness and tensile strength there will be low values for the ratio of endurance limit to tensile strength. If residual stresses are present such a reduction in endurance limit values would be expected. There is, however, some difficulty in explaining the reason why any residual stress affects the Brinell hardness number. It can be concluded, however, that there is some danger in interpreting fatigue values of such steels from tensile and hardness test data.

A further point brought out by the test is that steel A-2 possesses a very high endurance limit value and at the same time, high ductility. This steel is sometimes used for gears and it enables the employment of high working stresses without failure by fatigue coupled with the additional factor, due to the ductility, of being able to accommodate itself to the stress concentration encountered in such work.

In general we are justified in assuming that there will be a strict comparison between tensile strength and Brinell hardness numbers provided we have a homogeneous material. Any departure from homogeneity will show a difference because the tensile test is an average for the complete section while the hardness test is a surface test only. It seems therefore that this relation between tensile strength and hardness number is a linear one and that non-homogeneity as may be caused by residual stresses gives departure from the law.

This departure from the straight line relationship for the tests described is associated with a decrease both in tensile strength and in the ratio of endurance limit to tensile strength. This can be explained on the basis of there being residual stresses present.

Standardizing the Brinell Hardness Test

By H. M. German

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THE Brinell test is a measure of hardness by deformation. It is based upon the fact that if a hard and rounded object is pressed against a softer material having a flat surface and held in a rigid position, the hard object will deform or indent the softer material. The amount of deformation will vary according to the hardness of the hard object, the hardness of the softer material, the applied pressure, the rate of application of pressure and the time the full pressure is applied.

The hard object is a hardened steel ball ground to a diameter of 10 millimeters. Rockwell cone tests on several makes of balls show readings of 64 to 67. The balls are usually made from steel containing 1.00 to 1.20 per cent carbon and 0.50 to 1.25 per cent chromium. They are given a double treatment in hardening. The first treatment consists of heating to a temperature approximately 100 deg. F. above the critical point and quenching in either oil or hot water for the purpose of removing fabricating strains and refining the grain structure. In the second treatment they are heated to just above the critical point and quenched in water. The balls are not tempered. An ideal structure for Brinell balls consists of a very fine ground mass of martensite in which are imbedded fine grains of double carbides.

A. Hultgren has found that by cold working a hardened and polished steel ball, the surface is hardened to a sufficient depth to enable the ball to withstand considerably greater pressure than ordinary steel balls without appreciable permanent deformation. Balls given the above treatment permit accurate tests on materials up to number 700 Brinell hardness. He also reports that when testing hard steel, a sharper definition of the impression circle can be obtained by the use of etched balls. This is accomplished by etching, after cleaning with alcohol, in a one per cent solution of nitric acid in alcohol for a period of about three minutes.

The Brinell test has its limitations in that the only articles that can be tested are those that will stand permanent deformation and those that are of sufficient thickness and hardness that the force of penetration will not show a bulge on the opposite side of the test. That part of the sample to be tested should present a flat and smooth surface free from scale in order to

obtain a sharp definition of the impression circle under the reading glass.

When testing iron, steel and other comparatively hard materials, the standard load is 3,000 kilograms, but when testing soft materials, a load of 1,500 kilograms is frequently used. There are different types of Brinell machines which may be classified according to the manner in which the load is applied; namely, hydraulic, weight and levers, and weight and eccentric.

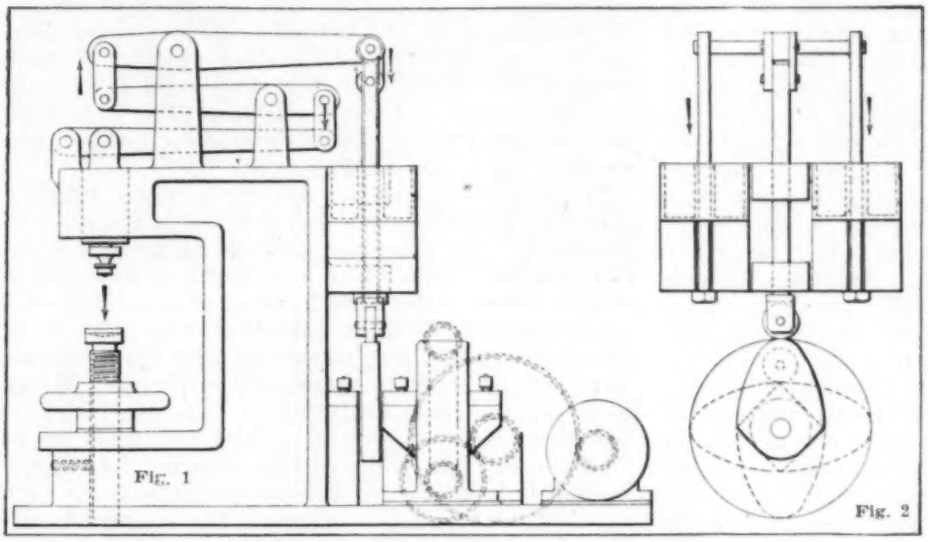

Fig. 1—Side view of the Brinell hardness testing machine. Fig. 2—End view, showing cams

In the hydraulic type different devices are used to regulate the pressure, such as gages, gage and springs and gage and check weights. The gage method is disadvantageous in that pressure gages do not permanently retain their accuracy. Regulating pressure by gage and springs is an improvement over the gage method and the danger of overloading is eliminated. When the pressure reaches a fixed load, a valve operated by adjustable springs opens so that a fixed load is maintained. Neither the gage nor the springs permanently retain their accuracy. The most common method of regulating the pressure is by means of the gage and check weights. In order to check the accuracy of the gage, a piston is provided with a dead weight control which limits the amount of pressure obtainable to that required for the test. This device has the disadvantage of overloading, as an extra pressure is necessary to overcome inertia in raising the weights and there is an extra pressure due to the rising and falling motion of the check weights in reaching equilibrium.

Most hydraulic machines have a tendency to leak after they have been in operation some time and the hydraulic fluid becomes stiff and sluggish in cold weather. There are two types of weight and lever machines; one, in which the load is obtained by weights and compound levers and applied to a plunger containing the ball which is pressed into the piece to be tested, and the other in which the test piece is pushed upward against the ball until it will balance a load obtained by weights and compound levers.

When making a test with the first type, the piece is adjusted snugly against the ball and then the load is applied by lowering the weights with a hand crank until the weights suspend free. The weights can also be operated by air or water pressure. Pushing the test piece against the ball is not so accurate as overloading is necessary to overcome inertia in lifting the weights and there is additional pressure due to the swing of the weights.

The weight and eccentric type of Brinell machines has the ball mounted so that it is forced into the material to be tested on rotating a lever attached to an eccentric. The load is regulated and applied by means of an eccentric together with the attached lever and weight. This machine also possesses the disadvantages of overloading to overcome inertia in lifting the weight and swinging of the weight. A review of the different types shows that only one, the first type of the weight and lever machine, will give an accurate and constant pressure. Metals when cold change in hardness and become more resistant to deformation up to the point of rupture. The extent of this change varies also according to the rate of the application of pressure. Provision should therefore be made to insure a steady application of the pressure and a fixed time for the application of the full load. A standard time should always be used. In commercial testing, the average duration is 10 seconds, but when more accurate readings are desired, 30 seconds will give more consistent results.

Recommended Design

A side view of a Brinell machine designed to overcome the described defects in the various types is shown in Fig. 1. Fig. 2 is an end view of the same machine, showing the operation of the cams. The machine is of the weight and lever type, the weights being lowered and raised automatically by means of a cam actuated by a constant-speed motor. As the cam revolves, the weights are gradually lowered and pressure is smoothly and gradually applied to the ball. When the cam has revolved approximately 90 deg., the cam leaves the roller supporting the weights and the weights are free to exert their full load upon the ball. There is no overloading to overcome inertia and there is no swinging or up and down motion of the weights. From points representing 90 deg. and 270 deg. in the revolution of the cam the full load is applied. The load is constant and the time is fixed. At a point representing 270 deg. in the revolution of the cam, the cam again engages the roller and raises the weights smoothly and gradually. When the cam has revolved nearly 360 deg., the current is automatically shut off so that the cam will make one complete revolution in making the test. If the speed is adjusted to make one revolution of the cam in one minute, the cycle would be as follows: 15 seconds for applying the load, 30 seconds for the application of the full load, and 15 seconds for the release of the load. By changing the gear ratio and the design of the cam, any desired time and rate of application and time for the full application of the load can be secured when it is desired to meet special needs and conditions.

Mechanical and Machining Properties of an Annealed Cast Iron

By G. C. Priester* and F. J. Curran†

CAST IRON differs materially from the other iron-carbon series of alloys not only in chemical constitution but also in physical characteristics. Because of its variable constitution, a slight change in the manufacturing process will cause a wide variation in its physical properties. On this account, the foundryman should know the use to which his castings are applied in order to properly control their manufacture and to insure their possessing the requisite properties. Therefore, in order to make a thorough study of the properties of cast iron, it is necessary to know the complete history of the product.

Ordinary gray cast iron is seldom heat-treated solely to improve its mechanical properties, probably because the cost of heat-treatment often greatly exceeds the little increase in properties. However, when other properties are taken into consideration, it is often more economical to make use of a heat-treatment. In the case of piston castings it is desirable for the material to have excellent machining properties because the cost of casting the piston is small in comparison with the machining cost of the finished product. An unannealed piston casting will show distortion after it has been machined, because of the variable internal casting stresses. To eliminate this distortion it is necessary either to age the casting for several months after the rough machining or to anneal it at a temperature which will relieve these stresses.

Heat-Treating Cast Iron

Since hardness is a factor in determining the ease with which cast iron may be machined, it was decided first, to study cast iron which was suitable for piston material and to heat-treat it in order that it be as soft as possible; then to study the machining and mechanical properties of the iron. To reduce the hardness of cast iron it must be heated to a temperature varying from 500 to 1,600 deg. F., depending upon the hardness desired. This paper presents only a study made on this material when it was heated above the critical temperature and allowed to cool partially in the furnace.

A commercial heat-treating furnace was charged with its average load of pistons and A.S.T.M. arbitration test bars in sufficient numbers to carry out a study of the mechanical properties of this cast iron. After the above charge had been annealed, the machining properties of the pistons were studied and the arbitration bars were tested for their properties. In order that a comparison could be made, the pistons and arbitration bars were tested in the unannealed condition, and hardness tests were made on pistons used by the manufacturers of automobiles. This test was carried out on new and used pistons in order to determine, if possible, the effect on their hardness after they had been subjected to actual commercial service, and to determine what hardness of pistons was commonly used by automobile manufacturers.

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The speed of cutting, the feed and depth of cut and the breakdown of the cutting tool were determined for the annealed and unannealed castings. Their mechanical properties were first determined on an autographic transverse testing machine. The ends were then machined to specimens suitable for tensile, compressive, shear and hardness tests.

The tensile test specimen was similar to the standard tensile specimen for gray iron specified in the A.S.S.T. Handbook. The difference consisted in using a diameter of 0.750 in. and a 2-in. gage length in order that a suitable extensometer could be attached to it. The compression specimen, which was round, was 0.750 in. in diameter and 3 in. long when used with the extensometer; but in order to fracture the specimen it was necessary to reduce its length to twice the diameter. The shear specimen was 4 in. long and 0.750 in. in diameter and was subjected to a shearing force while being held in a jig. No deformation instruments were attached to the jig or specimen. The scleroscope and Brinell hardness tests were taken on a polished cross-section of the specimen. On the softer specimens it was found that a more reliable value could be found for the Brinell reading by using a 1,500-kilogram weight.

Since phosphorus must be low to avoid segregation, the pouring temperature should be somewhat higher for the thin-walled pistons than for ordinary castings. The charge used for making the test castings consisted of the following: steel, 17½ per cent; charcoal pig, 55 per cent; scrap, 27½ per cent. The steel consisted entirely of railway splice bar of the following composition: carbon, 0.08-0.10 per cent; manganese, 0.35-0.60 per cent; sulphur, 0.06 per cent; phosphorus, not over 0.10 per cent. The charcoal pig had the following composition: total carbon, 3.50-4.25 per cent; manganese, less than 1.00 per cent; sulphur, 0.05 per cent; silicon, 0.75-1.50 per cent; phosphorus, 0.18-0.20 per cent. The scrap consisted entirely of foundry returns.

Analysis of the Specimens

All the specimens used in this study were tested as received from the foundry. The critical temperature of this cast iron was determined by the inverse rate method and found to be at 1,430 deg. F. All heat-treated specimens were heated above this temperature and cooled slowly so that they received a treatment commonly known as annealing in steel practice. The chemical composition of some of the specimens show satisfactory agreement with the charge used. The silicon, phosphorus and sulphur content are low and show that a good quality iron can be made into a thin casting.

Depending on the time and the temperature of the process, annealing will relieve the internal stresses of the cast-iron piston and, to a certain extent, eliminate the hard spots, break up the segregation and refine the structure. These points all tend to improve the machining qualities. The determining factor of the machining test was a breakdown of the cutting edge of the tool. The breakdown was due to the striking or chop-

ping effect of the out of round and uneven surface of the casting at the nose of the tool, causing the tool to break or push away from the work. All cuts were taken with a ground No. 3 Stellite toolbit flooded with a heavy stream of specially prepared coolant.

The machining tests show a decided advantage in favor of the annealed castings. The ratios obtained in the rough skirting and rough turning of the annealed and unannealed castings are approximately 2 to 1 and 6 to 1, respectively. The average endurance of the tool in the finish turning operation was in the ratio of 13 to 1 in favor of the annealed piston. This variation was, no doubt, due to the favorable condition of the internal structure produced by the annealing process. In the rough turning of the ring grooves, the end point of the test gave the ratio of 3 to 1 in favor of the annealed casting. For the finish turning, 5 to 1 was the ratio.

Casting Skin Not Considered

The bars used in the transverse tests were not machined and the influence of the casting skin on the properties was not determined. The heat-treatment of the test specimens decreased the bending strength about 29 per cent and modulus of elasticity about 9 per cent. While the average values of the deflection showed a decrease, it was comparatively small. The variation of the individual values was greater, however, than the average decrease. The heat-treated bars showed a greater increase in deflection with the same load increment than did the untreated bars, especially after being loaded above 1,500 pounds. It was noticed in performing the tests that the report or sound of the fracture of the heat-treated bars was barely perceptible or dull while for the others it was very distinct and snappy. This would indicate that the material had lost much of its brittleness in heat-treatment. All transverse specimens satisfied the standard specifications which are required by the American Society for Testing Materials.

Modulus of Elasticity

The modulus of elasticity of the heat-treated specimens under tensile test, showed a decrease of about 8 per cent in comparison with the value of those not heat-treated. The average value of this property in tension is a little higher than that obtained from the transverse test, as is to be expected. The tensile strength of the heat-treated specimens is decreased about 36 per cent as compared to the values of the not heat-treated specimen. For the Brinell and scleroscope hardness this same decrease is respectively 38 and 41 per cent. This indicates that the hardness test for this type of cast iron furnishes a good comparison of the relative tensile strength of the heat-treated to not heat-treated cast iron.

A stress-strain curve showed a straight-line relation for stress and deformation up to a stress of about 10,000 lb. per sq.in. for the heat-treated specimens and somewhat higher for those not heat-treated. Also the relative deformation showed a more rapid increase for the former than for the latter specimens after passing this straight-line relation. From the compressive tests the modulus of elasticity of the specimens showed a decrease of about 9 per cent, due to heat-treatment. The relative decrease in the compressive stress for the heat-treated specimens is about 40 per cent. After the specimen failed the angle of the plane of failure was measured. The shearing stress decrease is about 36 per cent. The computed and the measured angles of failure were in good agreement. It is possible, therefore, to obtain a satisfactory value for the shearing stress if the compressive stress and the angle of failure have been determined.

Microstructure of Specimens

In a study of the microstructure of the not-annealed specimens, an even distribution of the graphite particles throughout the ground mass was found. There were small areas of cementite near the graphite flakes. The ground mass was a fine-grained pearlite having a curly like structure. Annealing this cast iron above the critical temperature produced a complete change in the microstructure. A decided increase in the size of the graphite particles was found. The fine-grained pearlitic structure was entirely absent and the ground mass was then free ferrite. Deep etching of the annealed specimens brought out the grain boundaries of the ferrite when the specimens were subjected to high magnification.

In the annealed specimens, the combined carbon is nearly all eliminated. This elimination of the combined carbon reduces the hard spots in the casting and gives it excellent machining properties.

The length of time the heat-treated specimens were held at 1,650 deg. F. appears to decrease the modulus of rupture and the total deflection. The other properties do not seem to be affected to any appreciable degree by holding them at this temperature for an interval of time up to 3 hours.

Commercial Piston Tests

Automobile pistons used in commercial vehicles vary widely in Brinell hardness. In the case of used pistons, hardness values were found to vary from 187 to 103. As new pistons were not available in all cases it was impossible to decide what caused this variation in hardness. In one case a new piston had a hardness number of 182, while for the used pistons the hardness number varied from 172 to 113. If the used pistons were originally as hard as the corresponding new piston (there is every reason to believe they were), then the decrease in hardness in the used pistons was due to the temperature of the piston while operating in the engine under commercial conditions. Huebotter states that the temperature at the center of the head of a gas engine piston under full load is about 850 deg. F. Under extraordinary conditions this temperature may be exceeded. It is possible that the temperature could be sufficiently high to produce the decreased hardness. In the case of some of the used pistons, their hardness was equal to the value of the new pistons; and since no data were available on the time or condition of service of these pistons, it would be difficult to decide whether or not the operating temperature affected their hardness.

To summarize the data, in heating a gray cast iron above the critical temperature and cooling slowly, the machinability is benefited in the ratio of 6 to 1. The maximum strength properties and hardness are decreased from 30 to 40 per cent. The modulus of elasticity is decreased about 8 to 10 per cent. The maximum deflection under transverse loads is only slightly decreased. The heat generated by motors in operation may be sufficient to explain the decrease in hardness of pistons after use in commercial vehicles.

Wear of Steels with Particular Reference to Plug Gages

By H. J. French* and H. K. Herschman†

TESTS described in this paper represent part of an investigation of steels and treatments best suited for gages. The request for a study of gage steels by the Bureau of Standards was made through Col. J. O. Johnson, Chief of the Gage Section, Ordnance Department, U. S. A., simultaneously with the formation in 1922 of a group known as the Gage Steel Committee, consisting of representatives of gage producers and consumers, steel manufacturers and government departments.

The problem presented was divided into three parts as follows: control and possible minimization of dimensional changes in hardening; to secure dimensional permanence, i.e., the minimum of dimensional changes with time; and a study of steels and treatments giving the greatest resistance to wear. The tests to be described are of a preliminary nature and are to be followed by further work with the gage wear tester recently devised by the authors, as well as by additional service tests.

Among the recognized causes of wear are the following:

A. Rolling friction
   1. lubricated—as, for example, that between steel balls and the race in ball bearings
   2. unlubricated—such, for example, as that between a carwheel and rail.

B. Sliding friction
   1. lubricated—for example, that between a shaft and plain bearing
   2. unlubricated
      a. between two solid bodies such as a brake-shoe and wheel or a wheel and rail during braking
      b. between a solid body and an abrasive material of more or less fine grain such as that to which grinding, crushing and excavating machinery is subjected.

Aside from records of performance in actual service, a variety of laboratory wear testing machines have been devised for the study of different types of wear. The wide variation in the nature of the machines used by the different investigators for the study of wear of metals is of itself evidence that different effects are to be expected under different conditions, and this is readily confirmed by a study of the results obtained with the different machines.

Resistance to wear does not, in general, increase directly with tensile strength, indentation hardness (Brinell method) or hardness determined by other customary methods. Both indentation hardness and toughness are important factors affecting wear. Indentation hardness tends to decrease wear as it increases resistance to penetration, scratching or displacement of the metal. On the other hand, toughness tends to decrease wear by making it difficult to tear off from the metal the small particles which may be displaced. Wear usually takes place by combined displacement and removal of the metal of such small particles.

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Since both indentation hardness and toughness affect the wear of metals, factors such as chemical composition and heat-treatment which affect their indentation hardness and toughness may be expected to affect their wear resistance. The abrasive wear tests of Honda and Yamada indicate that martensitic (file-hard) high-carbon steels have less resistance to wear than the same steels with troostitic structures (file-soft). As stated by these investigators, the wear of carbon steels "is greatest under the normalized condition, and becomes less in the sorbitic, troostitic, and martensitic structure; but in high-carbon steels the wear of martensite increase beyond that of troostite or sorbite." Similar results were obtained by Robin who said that the steel C 0.63, quenched in oil, possesses less hardness than the same steel when quenched in water, although its resistance to wear by emery is greater. These results strongly indicate that file-hardness is not necessary for best wear resistance, at least for some important conditions of service.

Effect of Contact Pressure

There are many factors arising in service, apart from the character of the metals involved, which have been shown in different investigations to have an effect upon wear. One of the most important is the contact pressure either between rolling or sliding metal surfaces or between a solid metal and abrasives. The abrasion speed may also have a measurable effect upon the wear, and either conditions may increase the temperature of the test specimens and influence the comparisons which are secured. Contact pressures may readily be sufficient to work-harden the surface of specimens and at least temporarily cut down the rate of wear. In some cases the character of the surface is apparently of great importance in determining the rate and character of wear. High polish may decrease wear. Other factors are the presence or absence of a lubricating film and the nature, size and quantity of any abrasive particles present.

These conditions indicate that there is not now sufficient information available concerning the fundamentals of wear testing so that a problem of wear resistance may be put on a routine test basis.

About 125 gages were prepared from different steels, heat-treated in various ways, and submitted to a number of shops for tests under actual operating conditions, but after two years, less than half of this number had been returned with any information. Furthermore, careful examination of the performance records which were obtained showed that unless a sufficiently large number of additional gages could be prepared for wear in service, so that a statistical study could be made, little of the desired information could be secured. The variations in the conditions under which the gages were used, either in different shops or in gaging different parts in one shop made it impracticable to obtain desired comparisons and were suspected to have masked the effects of important variables.

Even without the details of the conditions under

which the gages were used, it is evident that the differences in service conditions either at different plants or in different jobs in one plant were sufficient to produce wider variations in gage life than appreciable differences in the composition and heat-treatment of the steels from which the gages were made. It was, therefore, considered advisable to carry out comparative tests under control in the laboratory, planning subsequently to check the principle conclusions by a relatively small number of tests in service.

The need for studying the wear of gages in the laboratory immediately brought up the question of a suitable testing machine. It was considered advisable to construct a special gage wear tester for the work in view. This machine is essentially one for repeatedly inserting plug gages into split rings, representing the material to be gaged, and permits control of a number of important variables such as the pressure between the gage and the work, the presence or absence of abrasives, lubricants, etc., and the metals from which both the gages and the material to be gaged are made. The machine provides for the simultaneous testing of two gages.

The gages used in all tests are cylinders 0.75 in. in diameter and 1.25 in. long, with a hole at one end threaded to fit the pistons of the wear tester. The split rings have an outside diameter of 1.5 in., a hole equal to 0.75 in., and a height of 0.375 in. All gages were ground and lapped but the rings were merely ground. With the gages and rings in place and the desired contact pressure between the two, the machine was started and run at a speed permitting 1,200 to 1,300 gages, and a ring rotation of about 900 revolutions per hour. After the desired number of gagings, the gages and rings were taken out of the machine and the wear determined by both decrease in diameter and loss in weight for the gage and loss in weight for the rings. Loss in weight was determined to the nearest 0.1 milligram by weighing the gages and rings on an ordinary chemical balance before and after each test. Change in diameter of the gage was determined from measurements on a Prestwich fluid gage made by the Coats Machine Tool Co., and tabulated.

Heat-Treatment of Specimens

Whenever possible the two heat-treatments applied to each steel were selected to give respectively "file-hard" and "file-soft" conditions, as one of the important questions raised by gage manufacturers was whether "file-hardness" is necessary and a criterion of good wear resistance. The selection of the various steels and treatments was dictated primarily by what had previously been done in the study of permanence and dimensional changes in hardening. By securing data on wear resistance for the same steels used in the studies of dimensional changes and permanence, a more complete picture is obtained of the value of the different metals for gage work. The chemical composition and heat-treatment of the rings, representing the material to be gaged, were not varied. The rings used in all tests described were "file-hard" and made from plain carbon tool steel containing about 1.05 per cent carbon water-quenched from 1,470 deg. F. and subsequently tempered at 300 deg. F. However, additional tests are now in progress in which the various gages will be used in contact with other metals such as commercial brass, aluminum casting alloys, soft steels and cast iron.

It was originally intended to make tests under two widely different conditions representing extremes encountered by gages in service: wear under dry sliding friction in which one metal slides over the other, and wear by abrasives. However, a number of difficulties were encountered which made it necessary to modify slightly these conditions of test.

With the gages sliding in direct dry contact with the split ring, even though very low contact pressures were used, an oxide film was soon formed which protected both gage and ring from further wear or at least reduced appreciably the rate of wear. To avoid such difficulties these tests were made in water in which was dissolved approximately 1 per cent by weight of potassium dichromate ($\frac{1}{17}$ normal solution of $K_2Cr_2O_7$) to minimize corrosion of the testing equipment, gages and rings. The presence of the water is not believed to exert any appreciable influence upon the wear. Since gages are frequently used in the presence of coolant during machining, the results should be equally as interesting and applicable as those from dry tests.

Abrasive Wear Tests

The tests on wear by abrasives were made with oil-emery or water-emery mixtures at first. The procedure finally adopted consisted in feeding through a small copper tube directly upon the gages at a point just above the zone of contact with the ring, 25 grams of emery per liter of lard oil (approximately 3.4 ounces per gallon), kept under continuous and vigorous agitation and suspension in a supply tank by means of a propeller driven by a small electric motor. Consistent results were obtained with this method. The two conditions of test to which reference has been made will hereafter be referred to respectively, as "metal to metal" and "abrasive wear."

Both the 1.06 per cent carbon and chromium ball-race steels are more resistant to wear by one metal sliding over the other when in the "file-soft" conditions studied than when "file-hard." Expressed in terms of the number of holes gaged per ten thousandth of an inch wear on the entering end of the plug gage, the "file-soft" high-carbon and chromium ball-race steels are about 2 to 3 times as resistant to wear, in these tests, as the same steels in the "file-hard" condition. In the "abrasive-wear" tests, the number of holes gaged per ten thousandth of an inch is more nearly the same for both the "file-soft" and "file-hard" conditions. Chromium-plate steel gages show a remarkably long life in the "metal to metal" wear tests, but only a slight superiority in the "abrasive" wear tests in comparison with the steel tested. However, for ordinary gage work in which both types of wear may be encountered, chromium plating appears to offer much promise. The principal difficulties with respect to the use of chromium-coated gages are now associated with the mechanism of plating, but with the attention being given to chromium plating practice, it should soon be possible to secure satisfactory coatings in a wide range of thicknesses on both simple and moderately complicated shapes without the "flaking" now frequently encountered.

The advantages of chromium-plated gages are not restricted to superiority in wear resistance under certain conditions of service. Apart from questions of cost, an ideal gage metal should be readily machinable, free from dimensional changes on hardening, dimensionally permanent in the hardened condition, and should have a high degree of wear resistance. The

advantage of chromium plating is that a soft metal base may be chosen which is readily machinable and dimensionally permanent and plated with chromium to provide the necessary surface.

Omitting for the moment consideration of chromium-plated gages, the most resistant to "abrasive wear" of the steels tested is the high-speed tool steel, but its superiority to the oil-quenched and untempered 1.06 per cent steel is practically negligible. In the "metal to metal" wear tests, the "oil-hardening" steel tempered at a rather high temperature subsequent to hardening is the most resistant to wear. Of the file-hard steels, the hardened and tempered high-speed steel is superior to the chromium ball-race steel which in turn is a little more resistant than the 1.06 per cent carbon steel.

It would appear from these tests that where abrasives are encountered, there is not much choice between the steels studied, with the exception of the hardened and tempered high-speed steel which is not quite as good as the chromium-plated gages. For unlubricated sliding friction of one metal on another, chromium-plated gages are so far ahead of the different steels and treatments included in this investigation that it does not seem worth while to consider any of the latter.

The results of the service tests seem to indicate, when considered as a whole and minor differences in gage life disregarded, that the water-quenched and tempered high-carbon steel is just about as resistant to wear as the chromium ball-race steel, either water or oil quenched. The chromium-plated steels showed up very poorly but this may be because they were plated several years ago. The results, however, indicate that the exact conditions for which chromium plating shows best wear resistance are not yet known.

Laboratory "abrasive-wear" tests showed that when a relatively soft gage is used opposite a hard ring, the wear of the latter is much greater than that in the former. This condition is found with the oil-quenched carbon steel, the annealed high-speed steel, the "oil hardening" steel when tempered at a high temperature subsquent to hardening, and, to a smaller degree, in the oil-quenched and tempered ball-race steel. The explanation is, probably, that the relatively soft gages become "charged" with the abrasive and becomes in reality an "emery lap."

To throw further light upon the wear resistance of the different steels and treatments, several sets of experiments were made in which the contact pressures between the gages and rings were varied. Within the limits investigated, the wear of the file-hard carbon steel gages and rings increases with the contact pressure in both the "metal to metal" and "abrasive wear" test. The wear of the file-soft carbon steel gages in the "abrasive wear" tests at first icreases, but then reaches a value which is not raised by further increase in the pressure between the gage and the ring. This condition may again be explained by the charging effect of the emery which makes the gage in effect an emery lap. The results indicate that change in pressure from that used in the comparisons of the different steels and treatments for gages would alter the numerical values of wear but not the order of superiority where appreciable differences originally existed.

Cyanide Brittleness

By V. E. Hillman* and E. D. Clark†

LOW-CARBON steel held at 1,500 deg. F. for 30 min. and quenched in the usual manner in water will not respond to heat-treatment to any marked degree. The metal remains tough and ductile and the tensile strength and elastic limit are only slightly affected. On the other hand, low-carbon steel immersed in a molten bath of sodium cyanide, salt and soda ash for 30 min. at a temperature of 1,500 deg. F. and subsequently quenched in water, possesses a martensitic case 0.005 to 0.006 in. in depth and a core which invariably appears to be extremely brittle. Such fragility is contrary to well-known metallurgical experience. The lack of toughness in the core is attributed by some writers to the absorption of nitrogen. It is said that cyanide embrittles the steel, due to the presence of nitride patches and needles. This may be true in so far as the case is concerned, but the core is not similarly affected. The experiments here described have been conducted to determine the cause of the brittleness of the core.

Six standard tensile test specimens were immersed in a commercial cyanide bath at 1,500 deg. F. for 15 min. and then quenched in water. The afore-mentioned procedure was repeated at 30-, 45- and 60-min. intervals. A total of 24 specimens were quenched. The percentage reductions of area and tensile strength in pounds per square inch were noted. The reduction of area furnishes a valuable indication of the ductility of the metal under examination. The percentage reduction of area incident to water quenching varied inversely with the time of immersion. Extreme brittleness was noted at 30-, 45- and 60-min. intervals. The cross-sectional area of the specimens presented the character of a quickly made fracture with a crystalline appearance.

A crystalline fracture usually results in intercrystalline failure. The brittleness of the metal becomes more pronounced as the period of cyaniding increases. The percentage reduction of area decreased from 62 to 0 per cent. A 30-min. cyanide treatment gave a reduction of area of only 4 per cent. The tensile strength of the metal also increases as the period of immersion is prolonged. This value is an index of brittleness. The tensile strength increased from 62,000 to 95,000 lb. per sq.in. for the water quench. Similar results were obtained with oil quenching, although to a lesser degree. The physical properties of the annealed test specimens prior to experimental heat-treatment were: tensile strength, 62,000 lb. per sq.in.; reduction of area, 62 per cent.

Forty-two additional standard test bars were cyanided, in groups of six, for varying lengths of time, at 15-min. intervals up to 60 min. and thereafter at ½-hr. periods, until a total of 2½ hours was consumed. The specimens were taken from the molten bath and cooled in sand. The superficial case was removed by turning the specimens in a lathe. The resulting diameter between shoulders was 0.40 in. The test pieces

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were then reheated to a temperature of 1,500 deg. F. in an electric furnace, quenched and tested.

The cross-sectional area of the specimens revealed a fibrous appearance which presented a grayish mass of rugged broken ends. No brittleness was in evidence. The percentage reduction of area remained in the vicinity of 62 per cent, notwithstandiing that the specimens were immersed in the cyanide bath for various lengths of time. The tensile strength remained fairly constant.

To substantiate the results obtained, a third set of forty-two specimens were machined. A set of six comprised each group. The test bars were cyanided, cooled in sand, turned in a lathe to 0.30 in. in diameter, reheated in an electric furnace and quenched. Again brittleness is lacking. This statement was borne out by the percentage reduction of area and tensile strength values.

As a final proposition, forty-two specimens were again cyanided for varying lengths of time and then quenched. The case was removed by grinding with the aid of a copious flow of water. The diameter between the shoulders was 0.40 in. The percentage reduction of area and tensile strength in pounds per square inch substantiated the statement that ductility was still in evidence. A slight average increase in tensile strength and a corresponding decrease in the percentage reduction of area was found as compared with the values noted in the two previous tests.

A number of specimens were cyanided for varying lengths of time, from 15 min. to two hours, at temperatures of 1,400, 1,425, 1,450 and 1,475 deg. F. The standard specimens were quenched in water. The diameter between shoulders was ground to 0.40 in. The results obtained on the tensile machine duplicated the properties mentioned in the preceding paragraph. The reduction of area hovered around 50 per cent. The values obtained indicate that the core is not affected at the afore-mentioned temperatures. The decrease in the percentage reduction of area is occasioned by the slight response of low-carbon steel to heat-treatment. The opinion was advanced that the apparent brittleness of the core with the case intact is probably due to the strained condition of the metal incident to quenching. In view of the suggestion a number of specimens were cyanided for varying lengths of time, from 15 min. to 1 hour, at 1,500 deg. F., quenched in water and reheated to 212 deg. F. for 1 hour. The specimens were tested for percentage reduction of area and it was found that the reduction remained around 4 per cent.

This indicates that a piece of steel which has been cyanided and quenched in water will snap readily when subjected to stress. When the case is removed the same metal possesses ductility. Therefore, the brittleness in the core is apparent and only apparent. The visible lack of ductility in the presence of the hard superimposed shell is occasioned by the intertwining of the grains in the case and the core. In the region where carburization, or nitrodizing, ceases, the hard and soft crystals are so mutually involved or enfolded that when the outer brittle layer is ruptured, failure is rapidly transmitted through the interior. Briefly, the brittle nitrogenous case acts as a seat of rupture. When the case is ground away the point of origin or the region of incipient breakage is removed. When the "case-free" metal is subsequently subjected to stress, no embrittlement is in evidence.

Stainless Iron at High Temperatures

By P. G. McVetty* and N. D. Mochel†

IN THIS paper the physical properties of annealed stainless iron and hot-rolled Monel metal at high temperatures are given, and a comparison is made with similar properties of other materials.

The strength of heat-treated stainless iron is superior to that of any of the other materials examined up to a temperature of 752 deg. F. This was shown by a study of the ultimate strengths, proportional limits, and moduli of elasticity. The ductility is extremely high and there is no tendency toward brittleness as is found in the blue heat range of medium carbon steel at about 527 deg. F. Between 752 and 932 deg. F. the ultimate strength is still higher than the other materials but it is generally conceded that the working stresses at elevated temperatures for steady stress conditions must be based upon the proportional limits rather than the ultimate strengths.

Most of the effect of heat-treatment of stainless iron and of 5 per cent nickel steel is lost at 932 deg. F. The heat-treated medium carbon steel retains some of the effect of heat-treatment at 932 deg. F. and it is interesting to note that its proportional limit is about the same as that of Monel metal which is higher at that temperature than that of any of the other materials examined.

It is usually considered that the properties of a heat-treated steel will not be affected by a working temperature which is lower than the drawing temperature of the original heat-treatment. This may be true if the time of exposure to the elevated temperature is short but it seems that time and temperature are interrelated and a similar annealing effect may be secured by long exposure to a lower temperature as that obtained by the original exposure to the drawing temperature. This condition is well known in the case of annealing nonferrous materials such as copper, but it is not so generally known that this fact may require consideration also in the heat-treatment of steels for applications at elevated temperatures.

The matter of deterioration of materials under exposure to elevated temperatures has been referred to by Fenwick, Mellanby and Kerr, especially in connection with turbine blading. The short time tensile test cannot indicate the effect of such conditions upon the material. We feel, however, that our long-time tensile tests which include the effects of time, stress and temperature, yield considerable additional information and are a step in the right direction.

In Table I there are tabulated data on the properties of stainless iron at 752 deg. F. before and after long-time tests at that temperature and various stresses. Most of these preliminary tests were made at stresses below the proportional limit at the corresponding temperature. Under these conditions the annealed material shows practically no change of properties as

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Table I—Stainless Iron, Annealed

Test No.	Preliminary Loading in Long Time Test: Lb. per Sq.In.	Deg. C.	Hours	P. L. Lb. per Sq.In.	Y. P. Lb. per Sq.In.	Ultimate Strength Lb. per Sq.In.	Modulus of Elasticity Million Lb. per Sq.In.	Elongation: 2 In. Per Cent	Elongation: 3 In. Per Cent	Reduction of Area Per Cent
8-2-5	.....	...	0	22,500	27,000	55,750	26.8	29.5	23.7	71.6
8-2-6	.....	...	0	19,000	26,000	56,500	26.5	29.0	23.0	69.5
8-2-3	18,000	400	168	19,000	25,600	56,500	26.2	31.0	25.7	71.5
8-2-7	18,000	400	168	20,000	26,250	56,850	26.0	30.5	24.0	71.6
8-2-8	18,000	400	168	20,000	26,150	57,250	27.8	29.8	20.8	73.1
8-2-9	18,000	400	168	20,000	25,400	57,000	28.1	32.0	25.7	71.8
8-2-22	18,000	400	742	.....	.....	58,000	....	30.0	24.0	68.8
8-2-41	18,000	400	742	19,000	25,000	56,500	27.0	30.5	24.7	72.3
8-2-1	30,000	400	909	28,000	33,625	56,650	27.0	28.2	22.1	64.7
8-2-16	40,000	400	2,153	36,500	45,800	59,300	25.8	25.0	19.4	70.7
8-2-14	50,000	400	1,990	44,700	61,300	70,000	26.8	17.7	11.5	64.2

a result of stressing at 752 deg. F. for a period of one month. At higher stresses in the preliminary test, the material was strain-hardened by the elongation and this hardening was not relieved by the temperature of 752 deg. F. This is shown by the increased strength and decreased ductility values of tests 1, 16, and 14. Similar tests of the heat-treated material, tabulated in Table II, show considerable variation in the results. This is probably due to the difficulty of securing absolutely uniform heat-treated specimens. These tests are being repeated with a new lot of material and the results will be reported later.

Cases still exist where materials are applied to high temperature conditions with a knowledge of the tensile properties at normal temperature only. Allowance is usually made for a decrease in strength but it is not so common to anticipate a decrease in ductility as the temperature is increased. This condition is noticeable in the "blue-brittle" range of steels at about 527 deg. F. and we find even more pronounced effects in brass at 752 deg. F. and in Monel metal at 932 deg. F. even though the ductility is high at 752 deg. F. When this condition exists, the fracture is liable to occur at any slight surface imperfection such as the grooves 0.002 in. deep used to locate the high temperature extensometer. This gives further proof that design data must be obtained from tests made at the temperature at which the material is to be used.

We have used a furnace of the type recommended by L. W. Spring and J. Kanter since the beginning of our high-temperature work three years ago. Under ordinary conditions, extreme refinement of temperature control may not be necessary. When, however, test conditions require that strain measurements be made to the nearest millionth of an inch it is evident that the expansion or contraction of the test piece resulting from very slight changes in temperature will affect these measurements. A gradual temperature change may change the slope of the stress-strain curve giving a false value of the modulus of elasticity. A sudden temperature change may indicate a false value of proportional limit. It has been shown that it is possible to control the temperature within 1 deg. C. over long periods of time. A much closer control is necessary over the elastic range of a short-time test. For close control it appears that at least 90 per cent of the necessary furnace current be applied continuously. The automatic control then operates by making comparatively small changes in the furnace current. This gives much better results than the common practice of controlling a relay which opens and closes the main furnace circuit. In this and in some other respects, the method of application is fully as important as the characteristics of the control instrument itself.

It has been shown that the interpretation of results of long-time tensile tests at high temperatures is largely dependent upon the refinement of the measurement of extension. It will be shown that a similar condition exists in determining proportional limits of all materials at elevated temperatures and also at normal temperatures with some alloys such as stainless iron. We have found that the Martens mirror-type extensometer which reads to approximately four millionths of an inch gives good results in short-time tensile tests. When it is necessary to take successive readings over long periods of time it is almost impossible to prevent disturbance of this instrument. To avoid this difficulty, we have replaced the Martens telescopes by a specially designed projection apparatus on all of our long-time tensile testing machines.

The apparatus is bolted rigidly to the frame of the testing machine. The lamp serves to illuminate the very fine cross-wires, the image of which is projected by the lens on the mirror and back to a scale on the

Table II—Stainless Iron, Heat-Treated

Test No.*	Preliminary Loading in Long Time Test: Lb. per Sq.In.	Deg. C.	Hours	P. L. Lb. per Sq.In.	Y. P. Lb. per Sq.In.	Ultimate Strength Lb. per Sq.In.	Modulus of Elasticity Million Lb. per Sq.In.	Elongation: 2 In. Per Cent	Elongation: 3 In. Per Cent	Reduction of Area Per Cent
8-4-32	.....	...	0	42,500	103,000	115,000	26.5	15.5	10.3	67.2
8-4-33	30,000	400	1	32,500	107,500	119,900	27.5	15.5	10.7	64.5
8-4-29	30,000	400	22.5	65,000	99,500	111,500	26.0	15.5	11.0	62.5
8-4-28	30,000	400	186.5	50,000	110,500	125,000	26.8	15.5	10.7	69.3
8-4-30	30,000	400	670	27,500	113,000	129,500	26.9	13.0	8.7	67.0
8-4-27	30,000	400	764	40,000	103,500	118,000	26.0	16.0	11.0	67.9
8-4-31	30,000	400	3,300	.....	.....	114,750	....	15.5	11.0	61.1

*Since these long time tests are made on bars of standard diameter (0.505 inch) the question of effect of bar diameter can be excluded from this comparison. Some of the creep data for these tests have already been published.

opposite wall. This instrument is easily protected from disturbance, requires no additional floor space, can be made at small expense and its accuracy is somewhat better than that of the standard Martens apparatus. With scales fifteen feet from the mirrors, it is possible to read to the nearest hundred-thousandth and to estimate millionths of an inch.

Work by Dr. McAdam and by one of the authors has shown that, in test at normal temperature, the values of proportional limit, elastic limit, and Johnson's limit may be widely separated under certain conditions depending upon the analysis and heat-treatment of the material. This condition is known to exist at elevated temperatures also and tests indicate that the difficulty of determining proportional limits of all materials increases as the temperature is increased. It follows that precise measurements of stress and strain are generally necessary for this determination at elevated temperatures and also at normal temperature for certain alloys such as stainless iron.

In a typical test curve for normalized medium carbon steel at 752 deg. F. the values of proportional limit and Johnson's limit are relatively close together but in the case of heat-treated stainless iron at the same temperature, they are 27,000 and 80,000, respectively. When comparative tests are made, it is essential that every precaution be taken to assure uniformity among the several test specimens. All of our steel test specimens used for deterioration tests are checked by Brinell and magnetic tests before their selection for use in tensile tests at elevated temperatures.

The conclusions that we have drawn so far may be summarized as follows:

Annealed stainless iron of the grade examined possesses good tensile properties up to 752 deg. F., without any indication of brittleness. Between 752 and 932 deg. F. the strength decreases more rapidly and the ductility increases. Hot-rolled Monel metal shows very good tensile properties up to 752 deg. F. but it becomes brittle at 932 deg. F. There is a very definite value in the heat-treating of stainless iron for applications up to 752 deg. F. At 932 deg. F. some of this advantage is lost and in the case of Monel metal, the material becomes very brittle.

Tests show that annealed stainless iron of the grade examined does not deteriorate as a result of exposure to stress and temperature for periods up to one month. Similar tests of heat-treated stainless iron show that the ultimate strength and ductility are not seriously affected by such exposure for periods up to 4½ months. Tests of this material are being repeated.

There is some confusion as to the use of the term "spline" in connection with a shaft. The term probably originated with the cutting of a long keyway in which a key or "feather-key" moved to permit the outer member to slide to different positions on the shaft. In these days of automobiles a splined shaft has from four to ten "splines" cut lengthwise, leaving an equal number of keys that are integral with the shaft. The space between the keys is usually called the spline.

Die castings can be made within a tolerance of 0.0025 in. per inch of diameter or length and with a minimum wall thickness of $\frac{1}{64}$ in. for small castings, and $\frac{1}{8}$ in. for castings weighing from 3 to 5 pounds.

Standardize on the Unilateral Tolerance

By Frank C. Hudson

INTERCHANGEABLE manufacturing has been the aim and the boast of American manufacturers for many years. And yet many of them still fail to understand some of the fundamental principles that underlie interchangeability.

The use of gages and fixtures alone does not make interchangeability, as many seem to suppose. Definite working tolerances are necessary in every case. "Absolute dimensions," which some claim, do not exist. And even with definite tolerances, much depends on the way in which they are set or given on the drawing.

The early setting of tolerances was bilateral—or "plus and minus," which probably grew out of the habit of saying "a thousandth (or a thirty-second) either way." But this method has the fundamental error of crossing, or overstepping, the basic dimension and making strict interchangeability impossible where the basic dimension appears in the drawing. With a shaft and hole both dimensioned 2 in. $\frac{+\ 0.001}{-\ 0.001}$ selective assembly is a necessity.

There is, unfortunately, some confusion regarding the use of the term "unilateral" as applied to tolerances. Engineers who have given the matter most careful study agree that "unilateral" tolerances must always start at the basic dimension, that they must be plus for holes, and minus for shafts or other mating parts, except for force fits. This does not mean that the basic dimension of a shaft to run in a 2 in. hole is necessarily 2 in. The basic dimension in this case is the maximum shaft diameter or the minimum hole diameter that will give the desired clearance for lubrication. For a force fit it is 2 in. plus the desired amount to secure the fit.

One of the advantages of the use of the "unilateral tolerance" is that standard gages can be used for "go" gages for both holes and shafts, except for shrink and force fits. And standard gages are always cheaper than those that have to be specially made. Bilateral tolerances, or where the basic dimension is not used in one-way tolerances, require that all gages be special.

Unilateral tolerances have so many advantages that it is time for all manufacturers who desire real interchangeability to study the tolerance question carefully at this time. Standardization in tolerance, as in many other practices, makes for greater economy and a better product. And when other countries are changing from the bilateral to the unilateral system, it behooves us to look alive and to make sure that we understand the situation thoroughly. This is no time to invent new systems of doubtful value, but rather to work for the simplest and most effective method of producing interchangeable work. And this is unquestionably by means of the unilateral system of tolerances, working from the basic dimension.

The reports of the committee of the A.S.M.E. that has been studying fits, tolerances and gaging for several years, are now available. They should be carefully studied and their recommended tolerances specified where possible. The adoption of standard tolerances for fits of various kinds will make it easier to bid on contract work and will prevent disputes as to the quality of workmanship desired and delivered.

THE · FOREMAN'S · ROUND · TABLE

Saving a Man's Face

The following narrative is a "case" presentation of the topic. It has been written to involve some of the questions that arise in the average shop. For guidance in preparing discussion the questions at the foot of the page have been prepared

"SAY, Ed, I've got to 'call' Bill Jones and I'm wondering just how's the best way to do it. He's a nice chap, but he will drag in a few minutes late every day or two and he's too fussy on some of the jobs. He used to work for you, Ed—how would you do it?"

"I haven't any time to waste worrying how to call a man down when he needs it, Al. I just call him down p.d.q. and make no bones of it. The sooner you get it out of your system the better. And the sooner he knows what you want done the quicker he'll start to do it."

"Don't quite agree with you, Ed, though I admit I'd like to bawl him out a bit. But he's a darn good worker for the most part, he's steady and more dependable than the average, and I don't want to antagonize him—don't believe it pays. Personally I'd probably get quite a kick out of blowing him up, for he's a bit exasperating in spots, but I want to make him a more valuable man to the company. And if he gets too peeved, he'll get a grouch that will cut his efficiency until he gets over it.

"The Chinese have a saying about 'saving your face' that means more to most of us than we like to admit. You remember, Ed, you didn't like to have the new super, who got fired, come out and jump on you before your men."

"You're dead right; I didn't, Al. I almost got to the point of throwing up my job and laying for him as he came out of the shop so I could black his eye. But the firm fired him before I made up my mind to do it."

"Bill Jones would probably feel the same about me, Ed, if I gave him a call in the same way. That's why I'm asking you about the best way to call him and still keep him from feeling that I'm down on him for some reason.

"Do you remember, Ed, how old Jenkins used to hit the ceiling when anything went wrong? How he'd cuss a blue streak and call a man everything but good and handsome? How he'd wax sarcastic and just take the hide off a fellow by trying to make him ridiculous. He was a good workman but to my mind he wasn't a good foreman. And I don't think I want to be like him."

Is Al right in trying to avoid hurting a man's feelings or is it better to let him know just how you feel whether he likes it or not? Are there cases where a bawling-out is the only way or the best way? Or can we handle all types of men without cussing or threatening in some way? How much does the foremen's handling of such cases affect loyalty of men to the company?

All foremen are urged to discuss these questions. Acceptable letters will be paid for. The discussion is not limited to foremen, of course

Discussion of Earlier Topics

Picking Assistants

EVERY executive from the foreman up is strengthening, not weakening his effectiveness by having a capable assistant. Two heads are better than one. It is not only necessary that a man shall be able to fill the next job higher up, but also that there shall be someone to step into his place, for him to be selected as the logical choice for promotion.

The best place to find the assistant is undoubtedly in the ranks of one's own department, because there are to be found the men familiar with the work and because to go outside creates a feeling that the foreman is not willing to give his own men an opportunity to prove their worth.

While it is difficult to make an absolute rating of the abilities of men, it is comparatively easy to decide their relative ratings for specific qualifications. Consider each qualification in turn. Let us say the first is *Initiative.* Lay out cards for the men's traits on a table and place them in order with reference only to the men's relative initiative. Mark the lowest "1," the next "2," and so on. Repeat this for each qualification. Finally, add up the scores.

If this does not settle the problem beyond any doubt, the qualifications should be weighted, each being given the percentage which its importance warrants, the whole list to add up to 100 per cent. The rating for each qualification on the men's cards is then multiplied by its percentage weighting, and the results again added up.—WALTER A. WOOD.

Teamwork in the Shop

A MANUFACTURING shop should have as its objective the production of a quality product at a minimum of cost. "Minimum of cost" stands without qualification, but "quality of product" varies with the nature of its function and the prescribed conditions of the customer, if manufactured on order.

Teamwork is absolutely essential in reaching the objective. Just as Red Grange, the football star, would be a "bust" if he had a "paper" line to protect him, which would allow the opposition to break through and stop him before he got started on a broken field run, so it is in the shop. The best kind of work in the machine shop will avail nothing, if the foundry supplies poor castings. Co-operation and co-ordination are the very life blood of a manufacturing shop.

An appeal for help from one foreman to another when something goes wrong, should be given every consideration. It should be looked upon in the light of its effect upon the shop as a whole, not in terms of the individual department appealed to. Even though it's in an outside shop, every consideration should be given, because the ultimate objective is an even flow of the maximum number of finished parts, not a race to pile up individual heaps of component parts.—F. E. SEILER.

Just What Is Discipline?

SHOP rules should be as few and as short as possible and make their intent clear. They must be free from any possibility of more than one interpretation, if there is any time during which the rule does not apply, or if it applies to a certain class only, such exceptions should be stated. But exceptions to a rule should be avoided wherever possible.

A thoughtful visitor realizes that he is a guest and abides by the rules governing the premises of his host. If he is not thoughtful about such things his attention should be directed to them. Any rule that cannot be enforced should be recalled.

I believe fooling or horseplay in the shop can best be kept in check by bringing to the attention of the workers actual instances of injury which have been known to occur, those of most recent date and happening nearest the shop being given preference. This can be done by posting shop bulletins. A small bulletin can be inclosed in the pay envelope.

A good way to secure discipline, an all-around good feeling and thorough understanding is to present each employee at the time of hiring with a brief explanation of the management's plan, and state that no rules have been or will be put in use except as they have been or are found necessary, and that the firm depends upon every employee to use good judgment and conduct himself in a manner that will be for the mutual benefit of both employee and employer without rules governing his every action.—JOHN MARK MAY.

Getting Information from Catalogs

THE world has moved a long way onward since the days of the old Roman who said, "Let the buyer beware." Catalog literature is gotten out, of course, to help sell the product but I doubt very much if any concern with a reputation behind it would take any chances on mis-statements in advertising. A machine tool builder will spend a lot of good hard-earned dollars in all sorts of experimental work to demonstrate just what his machine can do. One way of getting the facts before the men who may be interested in buying such equipment is through catalog literature.—ROBERT TAIT.

THE · NEXT · TOPIC

The Foreman's Main Job

QUESTIONS

How can you get production at a profit without slave driving?

Whose should be the job of assuring profits, the foreman's or the cost department's?

Will the foreman be better able to handle his job if he is relieved of the profit worries?

Ideas from Practical Men

The department, "Ideas from Practical Men," is devoted to the exchange of information on methods useful to the machinery industries. Its scope includes all divisions of the metal-working industry, from drafting room to shipping platform. Descriptions of methods or devices that have proved their value are carefully considered, and those published are paid for. The rates are from five dollars upward, according to their merit

Making Hand-Cut Files for Toolmakers

By Henry Densmore

A non-shrinking, high-speed steel is extensively used in the toolroom of the Westinghouse Electric & Manufacturing Co. at its East Springfield plant to make dies and punches for the laminations of which the magnets of motors are constructed. This steel is rather hard to work, and commercial files do not give as satisfactory results upon it as they do with other materials. Therefore many of the small files used by the toolmakers in this shop are hand cut, the work being done by an old-time filemaker who is a regular member of the toolroom force.

Cutting files for toolmakers

He makes small files of almost any shape desired, single-cut, double-cut, and special, to suit the purpose of the individual toolmaker, and he can make a file in a very few minutes. Standard shapes that are in constant demand he makes up ahead of requirements and they are kept in the toolcrib. All of his files are made of the same brand of steel they are to cut, and are carefully hardened and tempered.

The illustration shows the filemaker at work with the few simple tools that are peculiar to his trade. On the end of a wooden "horse," of which he sits astride, there is a steel plate to rest the files upon while he is cutting them. Two leathern straps, secured at the ends to the framework, pass over the ends of the plate and hang at the side in a loop. Into this loop the filemaker puts his foot to hold the file blanks down upon his anvil while cutting them.

The first, or "overcut," on one side of a file can be made with the blank lying directlty upon the steel anvil. For all other cuts a strip of lead or zinc must be interposed between the steel and the partly cut file to avoid injury to the teeth already cut on the underside.

The tool with which the cutting is done is a very ordinary cold chisel, though of a somewhat different shape than is used by toolmakers and machinists. One of them may be seen in the illustration. The cutting edge must be kept quite sharp, for which purpose the file-cutter has an oilstone before him.

The shape of his hammer is a heritage from the earliest filemakers, and though there is probably a reason for it, it is apparently beyond explanation. The user of an ordinary hammer would be able to hit with it almost anything but the object at which he aimed.

The expert filemaker, however, never misses the chisel, though the blows are delivered as fast as he can conveniently swing the hammer. The spacing, too, is remarkably uniform, considering that there is nothing but the skill of hand and eye to guide the chisel.

Hardening Cutters in a Drop Hammer

By Bernie Soule

Having occasion to make some special cutters about 6 in. in diameter and only $\frac{1}{8}$ in. thick for a certain experimental job, I found that my troubles began when I tried to temper them. After losing one or two, I adopted the following expedient, with excellent results:

In an adjoining room there was a "kick-drop," one of the kind that is worked by the operator putting his foot in a loop at the end of a leather strap that passes over a slowly revolving pulley at the top of the uprights, and thence down to the hammer head. When the operator "puts his foot down," the friction of the strap on the revolving pulley raises the hammer, and when he kicks back, the tension on the strap is released and the hammer falls. Hence the name of kick-drop.

This drop was equipped with dies of may kinds, among them being a pair with plane surfaces somewhat larger in dimensions than the diameter of my cutters. The dies being somewhat worn from long usage, I ground them flat and set them in the drop, and by dint of judicious shimming I was able to make them hold paper at all four corners.

I then spread a generous film of oil over the lower die, and rubbed as much as would stay there on the upper one. Taking a properly heated cutter from the

muffle furnace I laid it on the lower die and eased the upper die down upon it as quickly as I could.

Allowing a sufficient length of time for the cutter to assume the temperature of the dies, probably about 70 deg. F., I took it out and tried it on the job without further tempering. Much to my surprise it worked very well indeed, and lasted quite a long time, even though the material it was cutting was tool steel.

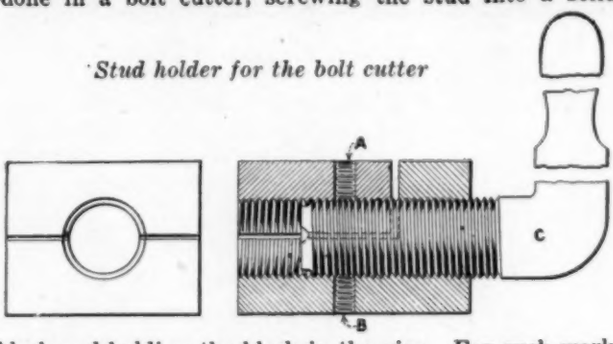
A Time-Saving Stud Holder

BY A. W. BURBANK

In making studs in a turret lathe, one end only can be threaded until after the stud has been cut off, requiring a second operation for threading the blank end.

In railroad shops, the second operation is usually done in a bolt cutter, screwing the stud into a solid

Stud holder for the bolt cutter



block and holding the block in the vise. For such work the stud holder shown in the illustration is a time saver. The holder is made in two parts as shown, being cut apart after having a through hole drilled and tapped to suit the studs.

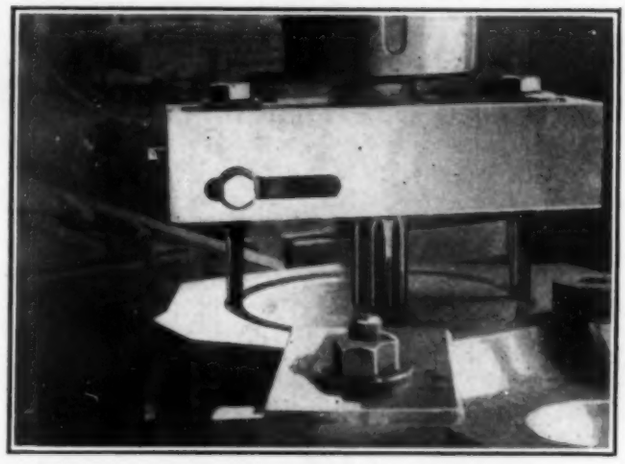
The serrated jaws of the vise are removed and the two parts of the holder are put in their place and fastened by screws that engage the tapped holes *A* and *B*. With the block open, a stud is put in, the holder closed and the locking screw *C* turned so it abuts the stud end. After the thread has been cut, it is necessary only to open the vise and turn the locking screw back slightly. The stud can then be lifted out and another one inserted.

The small hole in the end of the locking screw is to admit the tit left on the stud end by the cutting off tool, and allows the locking screw to abut the solid end of the stud, preventing the stud from turning under pressure of the cut.

Connecting-Rod Trepanning Tool

BY L. L. LOCKE

In the illustration is shown an adjustable trepanning tool used in a locomotive repair shop for cutting out the ends of main rods. The tool is composed of a square body that has a shank machined at its top side and a pilot inserted in the bottom side. Each end of the body is provided with a slot into which a sliding toolblock is inserted. An adjusting screw, having left- and right-hand threads, passes horizontally through the body and the toolblocks, so that the blocks can be adjusted in unison to a desired center distance. A square shank is provided at each end of the screw so that the adjustment can be made from either end of the body. The toolblocks are locked by shouldered screws in the top and side faces of the body. The



Trepanning tool for locomotive connecting rods

cutting tools have threaded shanks fitting tapped holes in the bottom faces of the toolblocks.

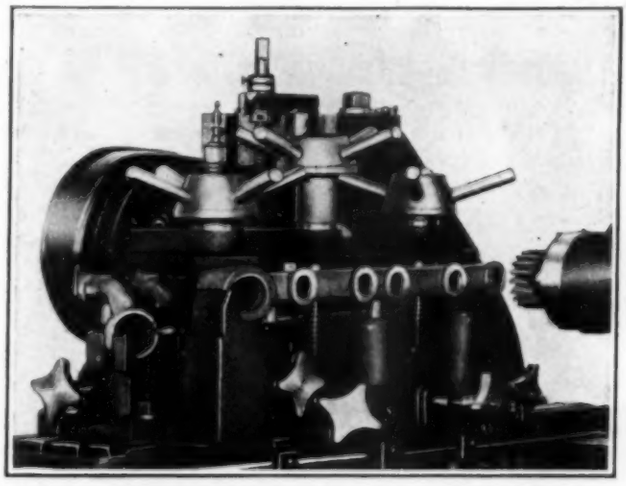
The work, shown in a Niles-Bement-Pond machine, is being trepanned to 10¾ in. in diameter. A 2-in. pilot hole, drilled in the center of the rod, is used to guide the trepanning tool. The thickness of the work is 5 in., and the cut is made from each side to a depth of 2½ in. The machine is operated at 14 r.p.m. and the machining time of each side is 30 minutes.

Milling Pads on Manifolds

BY GEORGE F. WATSON

By the use of the fixture shown in the illustration, we have been able to increase our production of manifolds and at the same time get out better work.

The fixture is double and holds an exhaust manifold on one side and a water-inlet manifold on the opposite side. The manifolds are located by fixed side and end stops and each one rests on three fixed supports, being further supported by a number of spring plungers.



Milling fixture for manifolds

The clamping is by three balanced clamps at the top, operated by pilot wheels. One pair of manifolds is completed at each pass.

The work is done on a 24-in. Cincinnati duplex milling machine and the production time is 2.55 min. per pair, the feed being 22.6 in. per minute.

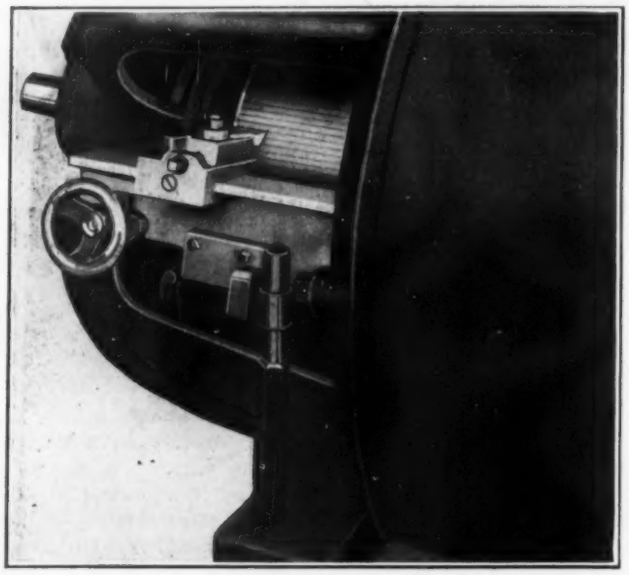
Device for Truing Commutators in Place

By Albert R. Kuzel

In order to true worn commutators without removing the armatures from the motors or generators, the A. B. See Elevator Co. has developed the device shown in the illustration.

The device is practically a portable lathe minus the head and footstocks. It consists of a bed of T-section, provided with a carriage and toolblock, and means for moving the tool in two directions. The carriage is traversed along the bed by a screw, operated by the handwheel shown, through helical gears. The screw and gears are at the back of the bed and do not show in the illustration. The toolblock slides across the carriage, being fed by a screw in the usual manner.

The device is held in place on the motor or generator by clamps. One clamp is attached to the left end of the bed and to one of the rocker-arm bosses of the machine.



Device for truing commutators

The other clamp is attached to the right end of the bed and to an upright that rests on one of the machine legs.

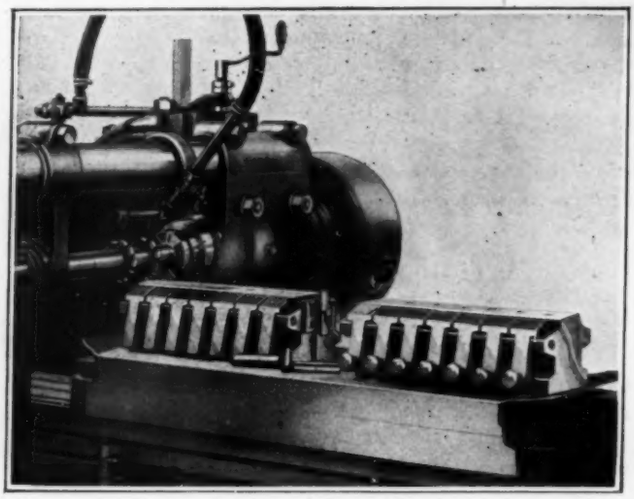
The size and weight of the device is such that it can be conveniently carried in a grip. It can be put in place, ready for work, in a few minutes.

Indexing Fixtures for Milling Turbine Blades

By John C. Davis

For form milling the insides of turbine blades, we are using the fixtures shown in the illustration, one fixture being mounted at each end of an indexing plate. The blades are located on a hardened steel plate in two rows of four, one row on each side of each fixture, separated by a hardened central strip. The clamps and operating screws are on opposite sides of the two fixtures, so that indexing for loading or unloading will bring the clamping screws for each fixture alternately on the side of the machine most convenient for the operator.

The fixtures are universal and will hold various sizes of blades by the addition of packing strips.



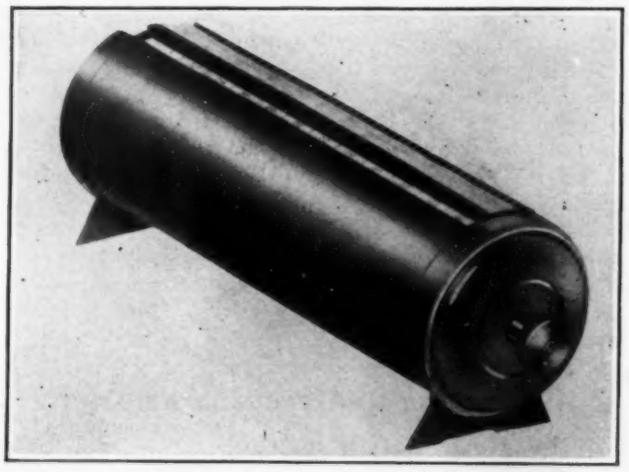
Holding fixtures for turbine blades

The material of the blades is 3½-per cent nickel steel and the time per piece is 0.52 min. The cutters are 4 in. in diameter and are form relieved. The work is done on a Cincinnati 48-in. W. D. plain automatic milling machine.

Convenient Holder for a Table of Wire Gages

By F. C. Mason

The holder for a wire-gage table, shown in the illustration, is very convenient for the engineer or purchasing agent. It is very easily made and consists of a tube, a holder for the table heading, a wooden roller,



Holder for a wire-gage table

two trunnions, two end pieces and a knob for revolving the roller.

The tube is slotted lengthwise to the same width as one of the lines of the table. The folder for the heading is made of thin sheet brass folded over at the edges and is soldered to the tube. The printed heading is slipped in and can be covered with a piece of celluloid if desired. The wooden roller is of such diameter as will contain the table when pasted around it. The trunnions are pieces of wire driven into the roller. The end pieces are stampings for a small ash tray we manufacture, which happened to be the right size.

Metal Working Industries Activity

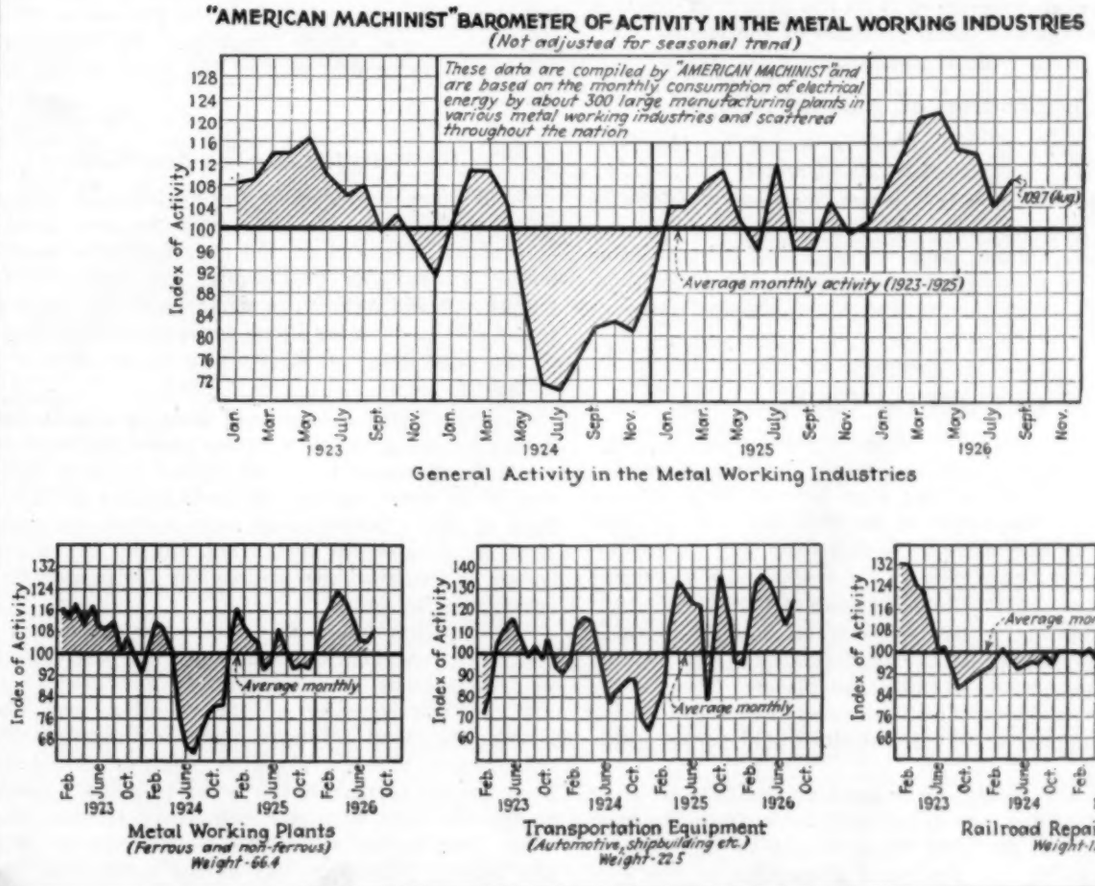
August Movement Above That of Last Year

Returns received on the consumption of electrical energy during August indicate that activity in the metal working industry of the country during the month was well above that of August of last year. Each month since the opening of the year with the exception of July, the movement in the industry has been above that reported for the corresponding month in 1925. The peak of activity during the present year was reached in March. Since then operations have decreased month by month until a slight upward turn was indicated in August. The general opinion among economists, however, is that the operations of industry will probably continue to decrease slowly during the remainder of the year.

The actual productive activity in the metal working industry during August was 5.2 per cent higher than that of July, and the same companies reported an energy consumption during August of 73,400,000 kw.-hr. as compared with 69,700,000 kw.-hr. in July. A comparison of the operations of the industry with past years shows that this increase in activity during August is normal, but that it is likely to fall off during September.

August operations in the metal fabricating plants of the country were about 3 per cent higher than those of July, and about 5.3 per cent higher than in August of last year. All sections of the country have reported a high rate of activity in these plants since January, but a decrease may be expected during the coming months.

An increase in the operations of the automotive plants was expected during August because of the fact that many companies are putting out new models at this time of the year. An error in compilation of some of the basic information on energy consumption has changed the index of activity of this industry as reported last month. The revised figures indicate that the peak of operations in these plants was reached in April, and that since then a noticeable decrease in activity has been recorded until August. July operations were below those of the same month last year, but August operations were 74 per cent higher than those of August of last year. The general opinion is that operations in the automotive plants will decrease with the fall months. Operations in the railroad repair shops during August were about on a level with those of July. The accompanying charts are based upon monthly figures on electrical energy consumption as reported to the *Electrical World* by manufacturing companies and repair shops.



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Practical Shop Problems

Questions of a Practical Nature will be answered in these columns

Magnesium Alloys

Q. I understand that a metal which is much lighter than aluminum is now being used for pistons and other parts. Can you give me any information regarding this material?

A. Magnesium has only about 60 per cent of the weight of aluminum, but commercially pure magnesium is a metal that has little or no value for machine parts because of its poor mechanical properties. However, alloys of magnesium with aluminum, copper, and other metals have been made and are being used where extreme lightness is desired, such as in aircraft construction, and for the reciprocating parts of engines. One of the best known of these alloys is called electron, and contains about 90 per cent of magnesium, and 10 per cent of aluminum, zinc, copper, and manganese. The specific gravity of electron is approximately 1.80 compared with a specific gravity of 2.68 for aluminum.

The lighter magnesium alloys are useful only because of their lightness. Their physical properties are poor, and they are easily attacked by either acids or alkalies. Trouble is also experienced from the danger of ignition of the turnings and small particles of the metal.

Composition of Natural Alloys

Q. Can you tell me what is meant by the term "natural alloy" as applied to Monel metal?

A. A natural alloy is one produced commercially in the same metallic composition as it is found in the original ore. Monel metal is produced directly from the sulphuric nickel ores, and contains the nickel, copper, and other metals in the same physical state as when mixed in nature.

Size of Chills for Chilling Iron

Q. We are casting chilled plates from 3 to 4 in. thick and 24 in. square, and experience difficulty from the breaking of the chills. We have been making chills on the basis that the weight of the chill block should equal the weight of the casting. Is there any way of calculating the proper size of chill by the coefficient of expansion and the stress produced on the edge of the chill?

A. It is unlikely that you will accomplish anything definite by mathematical calculations for the size of chills to be used in chilling the plates. The factors to be taken into consideration are so varied and erratic that even approximate calculations would be very difficult.

You are apparently not separating the two problems of heat absorbing power and expansion from the heat. The weight of the chill block should be sufficient to give it capacity for the rapid absorption of the heat necessary to chill the iron to the depth required. This is difficult to calculate since it depends upon the rate and temperature of pouring as well as upon several other important heat factors.

If the chill block as found by your experiments is satisfactory when made of a weight equal to the casting, then you simply face the problem of adding strength to the chill to prevent breakage. We presume that you are chilling on three sides of the plate, and that the chill breaks at the ends. You can strengthen the chill by redesigning it to give added strength to the weak sections, or possibly by making it in more than one piece as is done with the chills for car wheels.

Blank Sizes for Drawing Shells

Q. Will you please give me a rule to find the size of blank for drawing shells on such articles as the covers of cans?

A. The approximate size of blank for drawing straight shells is found by means of the formula $D = \sqrt{d(d + 4h)}$, where D equals the diameter of the blank, d the diameter of the shell, and h the height of the shell. For a tapered shell the formula is $D = 2h\sqrt{(d + d') + d'}$, where d represents the small diameter and d' the large diameter of the taper in the finished shell.

Restaurants for the Small Shop

Q. We are considering the installation of a shop lunch room where we will serve the noon meal only. Our plant is located on the outskirts of a small town where no suitable restaurants are available to the workmen. We have no experience in the matter, but would like to have the lunch room pay for itself. What is the experience of other shops under similar conditions?

A. Shop lunch rooms have been in use to such an extent for the past ten or fifteen years that considerable general experience has been gained in their operation. One of the most practical methods for the average small shop in your circumstances is to equip a suitably sized room as a cafeteria restaurant and let out a contract to one of the town restaurants for the preparation and serving of the food.

Many plants follow this method with success. The contractor provides the foodstuffs and the experienced help, and takes all responsibility for proper serving and for the cleaning of the premises and utensils. Prices are fixed by agreement between the factory management and the restaurant contractor, and are just high enough to permit the latter to make a reasonable profit. In this way you will avoid trouble likely to arise from trying to operate a business not allied in any way to your own, but at the same time you will have complete supervisory control over it.

Technical Abstracts

Design Trend of Machine Tool Motor Control

At present, machine tool designers are to a large extent inclosing driving motors in pedestals or bases. Adequate provision for ventilation must be made and there should be covered openings to make oil holes and commutators accessible. It is also wise to make removal of the motor easy. Design of tool, motor and control as a unit greatly simplifies the product and saves money for the customer. Face-plate dial starters are used for light duty, drum controllers for more severe service. Automatic starters of the counter e.m.f. and current limit types are widely used. Recently escapement-type time-delay devices have been developed for starting. These and other starters are controlled by push buttons or drum switches, the former growing in popularity. C. C. Runner in *General Electric Review*, September, 1926, p. 606.

Fuels for Heat-Treating Processes

The Bureau of Standards, in co-operation with an industrial firm recently discovered some new things about malleable castings. It was previously known that when malleable castings were galvanized, the heat-treatment that they received in the galvanizing bath decreased their impact strength to a material degree. This loss of strength was particularly noticeable in such castings as telephone pole-line hardware, which, on being installed, were often so brittle as to break when tightened with bolts.

A simple and at the same time most effective heat-treatment was developed to eliminate this difficulty. The castings were heated to a temperature of 1,200 to 1,500 deg. F., prior to galvanizing, and quenched in water. The heat-treated castings were then galvanized, and to the surprise of the investigators it was found that the impact strength was actually greater than that of the original untreated castings; often as much as 150 per cent more.—Milton Epstein in September *Machinery*, p. 6.

Neglect Ruins Precision Grinding Machines

The greatest abuse to which the average grinding machine is subjected is caused by dirt and neglect. Here is a machine designed to produce the most accurate work, yet it semes to be the general practice to let it take care of itself; less cleaning being given to it than to any other tool.

Nearly every case of faulty work produced by it can be traced to lack of conscientious care in wiping off the ways before applying fresh oil; wiping the tables and the bottoms of headstock or footstock before clamping; cleaning out center holes or the centers that go in them, and lack of attention to similar details. It has been our experience over a good many years that the majority of complaints against the machine have come from plants that clearly show neglect in this respect—and the more glaring the trouble the greater evidence of such neglect.

The modern grinding machine has become one of the most indispensable tools in the equipment of any machine shop. Its efficiency will be greatly improved and its life lengthened by treating it in proportion to its rating.—H. J. Warrick in *Abrasive Industry* for September, 1926, p. 283.

Europe's Attitude Toward American Methods

Europeans seem to think that American methods of mass production are a panacea for Europe's business and industrial troubles. They overlook the fact that such production is only possible because of the wide distribution attainable by reason of high wage scales and the general acceptance of standardized products in the United States. Racial and personal preferences in Europe combine with custom barriers to make wide distribution difficult. Then, too, the trained managers needed for large scale enterprises are not available in sufficient numbers. Caste barriers and reluctance to exchange technical and management information are also adverse factors.—Sam A. Lewisohn, in *The Management Review*, September, 1926, p. 263.

Cobalt in High-Speed Steel

Cobalt has not found much favor in the steel industry up to the present time, although it has been added in small percentages to high-speed steel. Recently an alloy has been put on the market in Germany containing approximately 38 per cent of cobalt, 30 per cent of chromium, 16 per cent of tungsten, 10 per cent of nickel, 4 per cent of molybdenum, and 2¼ per cent of carbon. When tested as a cutting tool it has proven to be much superior to high-speed steel. In the non-ferrous metals industry cobalt has not found much use. —Thos. M. Pugsley, in *The Mining and Industrial Magazine* (Johannesburg, South Africa), Aug. 11, p. 545.

Waste in Electric Lighting

The New York Edison Company has 2,000,000 electric meters installed in New York City, and for keeping a check on electric current consumption the company has kept a record of bright and dark days for the past thirty years. The company has found that weather has a marked influence on the use of artificial light in business houses and factories. During January, 1925, for example, 44 per cent of the days were cloudy and required the use of light, while in January, 1923, 57 per cent of the days were dark. This helps to explain the large lighting bills that are often the subject of contention.

In checking up the complaints of customers, however, the company has found many cases of plain waste. Frequently lights are carelessly left burning in out-of-the-way places such as cellars, back stairs, and vaults. Customers considering only the conditions during business hours also fail to realize the large extent to which illumination is required and often wastefully used for cleaning purposes during the night hours.

Again, defective wiring or devices may permit electricity to leak much the same as water leaks through defective piping. The meter does not distinguish between a proper use and an unnecessary and wasteful use of electric energy.—Arthur Williams, in *The American Zinc, Lead and Copper Journal*, August, 1926, p. 5.

Industrial Radiology

X-rays are generated when a high-tension current of electricity is passed through a vacuum tube suitably designed to withstand the heat developed, these rays penetrating opaque substances in inverse proportion to the density of the substance examined. X-ray spectroscopy is yielding astonishing results in the hands of workers in this branch of science.

In industrial radiology, high-vacuum tubes, utilizing high voltages, are employed almost entirely, the voltages varying from 50,000 to 200,000 volts, depending upon the opacity of the substance to be examined. The testing of materials is becoming of increasing importance, and the internal structural examinations for uniformity of finished castings and other products can only be effected by radiographic methods.

The high-vacuum tube contains a cathode electrode of platinum or tungsten, and a focusing device consisting of a molybdenum cylinder and a tungsten target. A "Coolidge" high-vacuum tube costs about $300, and has an active life of about 120 hours.

The manufactured substances that are examined industrially by means of X-ray methods are: Cartridges, torpedoes, rubber tires, electrical cables, and engine parts. Radiographic analysis of alloys also reveals any unequal diffusions of the components of the alloy. Steel castings are also examined for defects by this method.—E. W. Lewis, in *The Engineer* (London), Sept. 3, p. 252.

American Machinist

KENNETH H. CONDIT AND FRED H. COLVIN
Editors

Established 1877

Pulling Together

ABOUT the hardest job imaginable is to conduct a business where harmony is marred by inter-departmental jealousies. If the engineering department is inclined to be uppish because it designs the product, or the production department stand-offish because it builds the product, or the sales department upstage because it sells the product, the chances are that it will not be long before there will be no orders to fill, no product to sell and no money for engineers' salaries.

Before that time comes it is up to the manager to find out where the hidden trouble is, get all the cards on the table and remove all misunderstandings. If there are still individuals who don't feel co-operative there is only one place for them and that is outside. Any other course is fatal to the business.

An Organization for International Standardization

A COMMITTEE of representatives of the standardizing bodies of seven different countries is meeting in London to decide on the best form of organization for the machinery of international standardization. The delegate from the United States goes uninstructed save that his constituents favor some form of organization that will permit of the continuance of the existing American standards procedure through the American Engineering Standards Committee. It is to be hoped that some way will be found to make use of some such existing means as the International Electrotechnical Commission so that it will not be necessary to get together an additional set of professional secretaries. It should be possible to change the name, aims and personnel of the I.E.C. to meet the requirements.

The first question that comes to the disinterested mind is, "What things are suited for international standardization?" Super-engineering bodies have fizzled out before now because nobody could find anything for them to do. In the metal-working field dimensional standardization is of primary importance. It is so important, in fact, that any other form of standardization is apt to be forgotten. If dimensions were the only things to be standardized internationally there would be little prospect of early achievement because of the many difficulties to be overcome—notably the use of metric or English units. But there are the standardization of procedure and of material specifications to be considered and also of nomenclature and symbols. Internationally accepted test codes for power apparatus would be a great boon to manufacturers of this type of equipment. Ratings of machines that might have universal recognition would also be useful.

There are jobs to be done, therefore, and eventually the means will be found. It will be advisable, however, to go slowly in setting up the machinery.

Assuming Local Responsibility

ACCEPTANCE of responsibility is at once a rare trait and an evidence of bigness on the part of a man, a company or a community. There is nothing more common than avoiding responsibility by shifting it to the shoulders of someone else, and nothing more demoralizing.

One of the best proofs of the statements just made can be found in the attitude of officialdom toward taxation and budgets. At Washington the Federal Government has faced the issue squarely. Expenses have been reduced, wastes eliminated and the budget balanced. As a consequence the country has been relieved of an appreciable part of its national tax burden. The state governments, on the contrary, have done just the opposite. They have borrowed money, pyramided expenditures and set up budgets that can only be balanced by greatly increased taxation. The responsibility for relief from this situation cannot be passed on to Washington, it must be faced by the citizens of each state. County and municipal responsibilities must likewise be borne by local citizens. Each community can best solve its own problems if it will. The same reasoning can be applied to any business or industrial organization, large or small.

Additional evidence that there are many questions that should be solved locally is found in the American farmer's problem. Many attempts have been made to treat it nationally but quite without success because a solution that serves in one district is totally unsuited to another one. Business and industry must co-operate with agriculture in the attack on the farmer's troubles but the strategy to be adopted should be local or regional rather than national. The Chamber of Commerce of the United States is right in stressing this point.

The greater the development of machinery to do the work formerly done by man, the greater has been the prosperity of the workman and of the country.

Shop Equipment News

Bullard 6-In., 4-Spindle Mult-Au-Matic

The 6-in., 4-spindle machine shown in the accompanying illustration has been added to the line of Mult-Au-Matics marketed by the Bullard Machine Tool Co., Bridgeport, Conn. Besides differing in size and number of spindles from previous models, the machine is claimed to be more economical of space and to have incorporated several important features of the smaller sized machines.

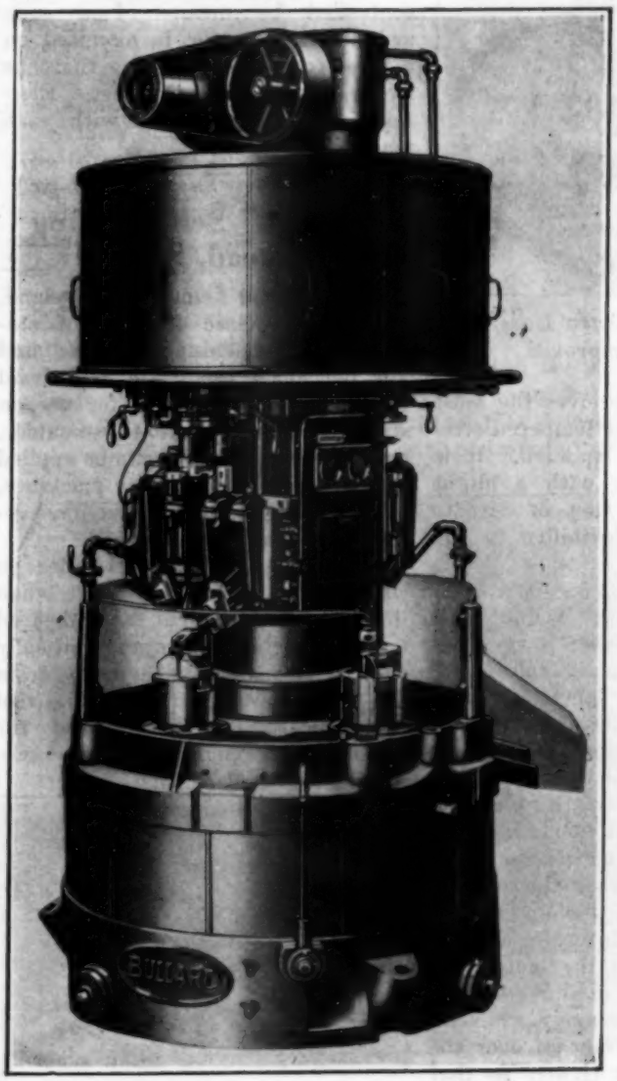
The 6-in. Mult-Au-Matic has a heavy circular cast base, which contains reservoirs and pumps for both the lubricating oil and the cutting compound. The central column is square in section with the tool heads and ways mounted on three faces. On the fourth face a door is provided as a means of access to the mechanism.

The compartment at the top of the base contains the carrier indexing arm, the spindle-drive gears, and the chuck-operating mechanism. The work spindle carrier supports four spindles equally spaced about the central column. The front spindle is the loading station, and the other three are machining stations.

The feed mechanisms for the machining stations and the clutches are mounted at the head of the central column. The cover of the feed mechanism compartment contains a distributing reservoir for lubricating oil, which floods all operating parts during the operation of the machine. It also provides a platform for the drive bracket and motor mounting.

A feature of the 6-in. Mult-Au-Matic is the power chucking device. The mechanism of this device is at the loading station, and connects with each spindle in turn as it comes into position for loading and unloading. By a single throw of the operating-lever in either direction the work is gripped or released. The device is claimed to be suitable for operating standard or special chucks or for special holding fixtures. The amount of jaw pressure required for various pieces of work may be set to suit the particular job.

The three machining stations may each be fitted with plain vertical, compound horizontal, or standard universal heads, giving vertical, horizontal, or angular tool feeds. Double purpose heads can also be used to give a vertical feed combined with a horizontal or angular feed at a single station. The illustration shows the loading station at the right, and at the left a double purpose head for vertical and horizontal feed combined with a live spindle drill head for multiple operations.



Bullard 6-In., 4-Spindle Mult-Au-Matic

The full swing of work is 10 in. in diam. for pieces 5 in. high, and 6½-in. diameter swing for higher work up to 7½ in. maximum. The tool heads have 5½ in. vertical travel with a maximum of 2 in. for cross or bevel facing. The top of the chuck is 35 in. above the floor line.

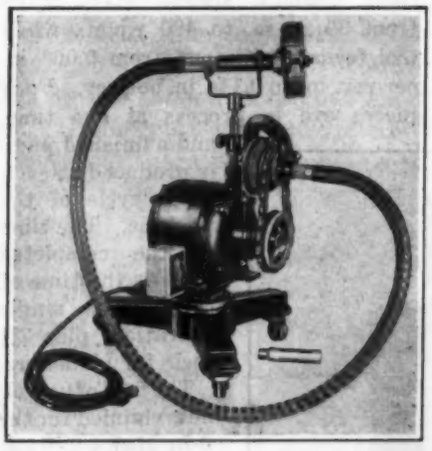
Adjustments of spindle speeds and feeds are through change gears in the upper compartment, and give an independent adjustment at each station. Spindle speeds may range from 30 r.p.m. to 480 r.p.m., while tool feeds may be set from 0.003 in. per rev. up to 0.114 in. per rev. Four pieces are in process at one time, and a finished piece is produced at each index cycle of the machine. The time of the completed piece is the time of the longest single operation plus 2½ sec. for indexing.

The field of usefulness claimed for the 6-in. Mult-au-Matic comprises the smaller pieces for which the greater capacity of the larger machines is not required. The small machine is suitable for quick set-up, and more frequent change of tooling, and is claimed to be economical on short runs of work. Power for the machine may be obtained either by belt connection from a countershaft, or by means of individual motor drive. In the latter case a 7½-hp. motor at 1,800 r.p.m. is recommended. The overall height of the machine is 104 in., and the base covers a floor space 48 in. in diameter.

Shop Equipment News

Haskins Flexible Shaft Equipment, Type H-6 Improved

The R. G. Haskins Co., 3446 Lake St., Chicago, Ill., has made several improvements on its flexible shaft equipment of which the caster base model of the H-6 equipment is illustrated. All types of shafts manufactured by this company, with the exception of the No. 1 and No. 2, are triply reinforced with high-carbon tempered flat steel wire. This construction provides the interior of



Haskins Flexible Shaft Equipment Type H-6, Improved

the casing, which receives the most wear, with a layer of tempered steel spring wound on a mandril. It is cylindrical in form with a slight space between each turn of wire to allow the proper flexibility in the casing.

Over the inside spring is a layer of cord fabric tightly wound on a bias. A layer of rubber is then put over this layer and vulcanized. Another layer of fabric is next wound in the opposite direction and a second layer of rubber vulcanized to it. Over the second layer of rubber is wound another high-carbon tempered flat steel spring. This outer spring acts as a protection against abrasion from the outside and from constant flexing of the shaft. Two heavy reinforcing springs have been placed at the motor and spindle ends. The casing ends are fastened on the casings with compression prongs. They go over the steel spring and fit tightly so that there is no chance of their coming loose. The ends are made of heavy Shelby seamless steel tubing and are threaded to receive the spindle at one end and to fit on to the motor coupling at the other end.

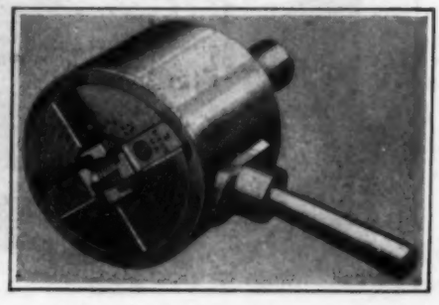
At the spindle end a swivel coupling connection has been provided. This has been provided so that the shafting cannot break down at the spindle end when it is subjected to constant twisting and bending to get into angles and corners. The spindle, with this fixture, is free to swing in a complete circle so that there is no twisting strain on the casing. The coupling is designed so that it is larger than the casing itself and can be comfortably held in the hand.

The shafting on the equipment illustrated is driven through a two-speed cone pulley from a motor controlled by means of a snap switch. The motor is mounted on a three-footed base casting that has casters on each of the feet. Electrical cord is provided with each machine.

"Namco" Self-Opening Diehead, Style S

The National Acme Co., Cleveland, Ohio, has revised its line of stationary self-opening dieheads and has developed the Style S diehead illustrated. The tool is for use on straight-away, close-to-the-shoulder, or short threading. It can be applied to all types of hand screw machines, turret lathes and other machines requiring a stationary diehead.

The shank of this tool rides on coiled springs so placed that when the thread has been cut to the desired length the chasers are automatically thrown open and pulled away from the work by the springs. The tool can quickly be disassembled for cleaning by removing two screws.



"Namco" Self-Opening Diehead Style S

After cleaning, the diehead can be reassembled without affecting the size adjustment in any way.

The size adjustment for the diehead can be made with a screwdriver without removing the die from its holder. The adjusting screws are located in the periphery of the cup, and the adjusting ring is graduated for ready reference. Seven sizes of the Style S diehead have been placed on the market to cover a cutting range of from ⅛ to 2½ in. The sizes correspond with the range of the Style R revolving type previously described on page 179, Vol. 64 of the *American Machinist*.

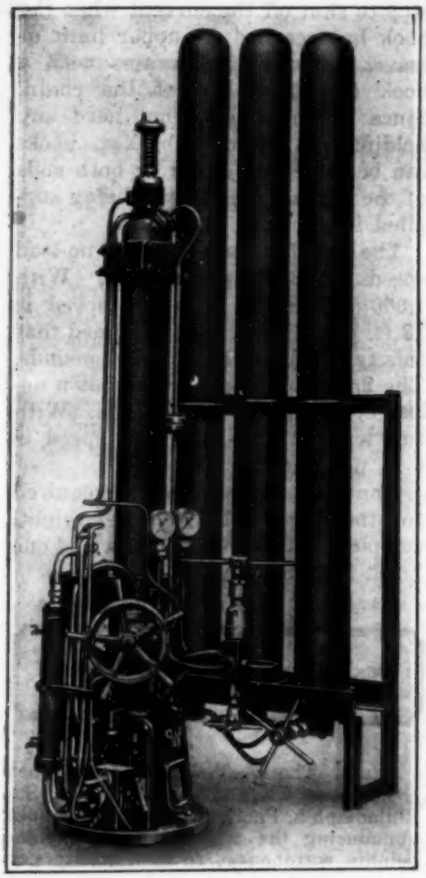
Elmes Hydraulic Accumulators

Under the Werner and Pfleiderer patents, the Charles F. Elmes Engineering Works, 1001-1003 Fulton St., Chicago, Ill., is supplying hydraulic accumulators designed to provide an elastic medium to act as a cushion and eliminate shocks with sudden changes in stroke and wide variation in the amount of liquid withdrawn from the accumulator and to overcome the difficulties which are sometimes met when the gravity accumulator is used.

Advantages claimed for the accumulator are the economy of space and head room, the fact that the accumulator can be located in any convenient part of the factory, the elimination of shocks and the usual troubles from such sources, closer regulation of pressure, and uniform delivery of pressure.

The complete installation comprises an accumulator cylinder, a battery of compressed air storage tanks, a high pressure pump and an air compressor. The materials of which the apparatus is built include seemless steel for the air cylinders and storage tanks, and steel forgings for the hydraulic cylinder. All pipe connections are of high-pressure steel. A permanent increase of the working pressure may be obtained by pumping more air into the storage cylinders up to the point required. Decrease of the working pressure is effected by simply releasing the air down to the desired point. The only function of the compressor is to give the system its original charge and to make up for

Shop Equipment News



Elmes Hydraulic Accumulators

losses of air. The compressed air remains in the system and is used only for generating pressure.

The accumulators can be supplied in pressures of from 300 to 8,000 lb. per sq.inch.

"Marvel" High-Speed-Edge Saw Blade

A hacksaw blade with a high-speed edge has been placed on the market by the Armstrong-Blum Manufacturing Co., 347 North Francisco Ave.,

"Marvel" High-Speed-Edge Saw Blade

Chicago, Ill. The edge is made from high-speed steel, welded to a tough, back or body. The blade is designed to combine the qualities of the tungsten steel edge with the non-brittle saw blade body to prevent breakage of the blade.

The saw teeth of the edge are designed with an undercut shape of tooth which, it is claimed, will cut more rapidly than the ordinary straight or milled type of tooth. The blades are being supplied in 12, 14, 17, 18, 21 and 24 in. lengths.

Gridley Single-Spindle Automatic Turret Lathe

The National Acme Co., Cleveland, O., has brought out in its Windsor, Vt., factory, the improved Gridley single-spindle automatic turret lathe shown in Fig. 1. The claims made for the improved machine are increased power adaptable to the most modern machining requirements of feeds and speeds, ease of change over, and greater sturdiness to reduce maintenance costs. The improved machine is being featured in the 4½-in. size.

The principle of the machine is the same as in the former designs of Gridley single-spindle automatics. The turret is of square section supported by a heavy stem which passes lengthwise through the frame of the machine. This stem is mounted on heavy bearings at both ends. The toolslides are gibbed to the four faces of the turret, and are operated parallel to the axis of the spindle by cams. The design of the slides permits tools to be supported without overhang, and allows for multiple operations by mounting one tool behind another on the same slide.

On the improved machine the two driving belts and two auxiliary belts are replaced by one broad belt or by a single constant-speed motor. This simplification is accomplished by a geared head built into the headstock and having one set of change gears for the spindle speeds and feeds, and a second set of gears for changing the feed independently of the spindle drive.

The power for driving the machine is delivered through a large pulley mounted on the end of the gear-case shaft at the left-hand side of the head. This shaft has a roller bearing next to the pulley to take the strain of the heavy belt pull. In Fig. 2 is shown a rear view of the geared head with the cover removed.

The combination of direct and planetary drive, which allows the camshaft to operate at high speed during the indexing, is retained in the improved machine. The purpose of this mechanism is to minimize the non-productive time of indexing and

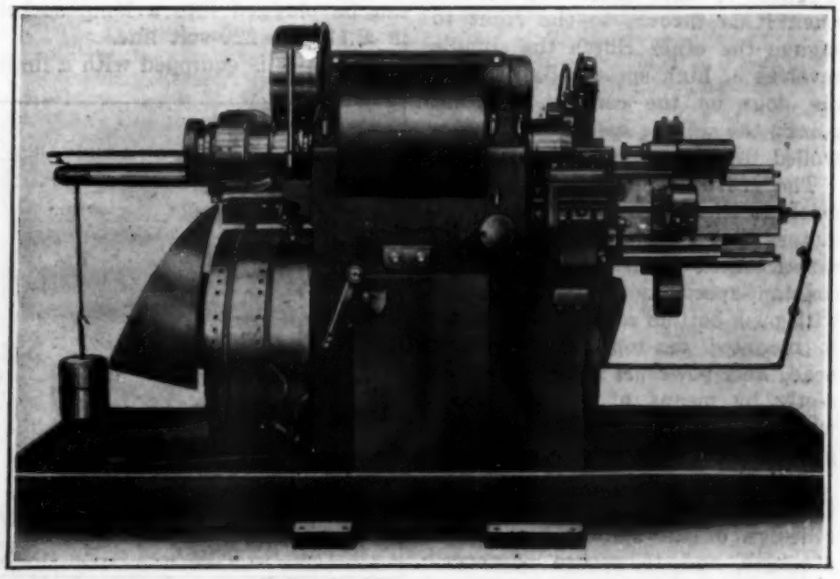


Fig. 1—Gridley Single-Spindle Automatic Turret Lathe

Shop Equipment News

also that of idle tool movements.

The three pulleys on the spindle of the former machine have been replaced by two gears on the spindle drive shaft that mesh with two gears keyed to the spindle. The gears on the spindle drive shaft are mounted on friction clutches between which there is an operating spool. The clutch spool has a swinging fork operated by dogs on the cam drum, which is just below it. When the spool is thrown to the left the spindle

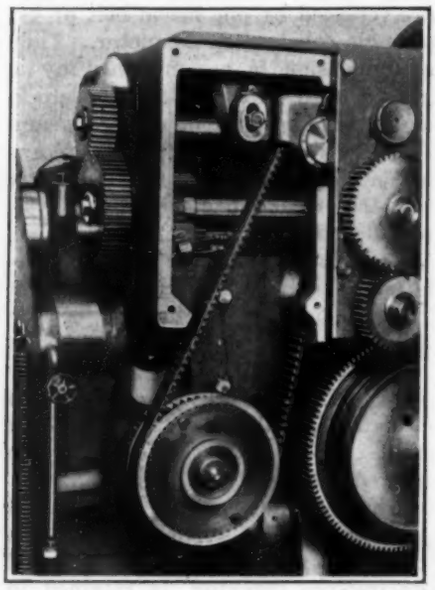


Fig. 2—Rear view of geared head with cover removed

is caused to move at slow speed, and when it is thrown to the right to engage the other clutch the spindle revolves at high speed. By locating the dogs on the cam at different points, the spindle speed may be controlled to suit various operations.

The geared head on the improved machine eliminates the need for two motors and a complicated system of cam-actuated controls. A single constant-speed motor is now used with push-bottom control. The motor is mounted on top of the geared head, and power is transmitted directly by means of a silent chain which is completely covered by a guard.

Other refinements incorporated in the present machine include complete redesign of the spindle for greater strength and to secure concentric rotation of the collets, and bronze bearings to suit the increased power. The machine is equipped with a force-feed lubrication system which furnishes ample oil under high pressure to all bearings. The tools and work are also flooded with cutting compound under pressure in order to wash away chips as well as to cool the work.

"Immunite" Welding Lens

Strauss & Buegeleisen, 30 Front Street, Brooklyn, N. Y., have supplemented their line of standard welding lenses with the "Immunite" welding lens. It is claimed that the lens is optically ground and polished to an exact plane.

The lenses are designed to meet the requirements of the most recent specifications of the United States Navy. They can be ordered and specified by shade numbers and with each lens a certificate is given specifying the absorption of ultra-violet and infra-red rays, visibility and the total energy transmitted by each lens.

"McCollum" Universal Electric Hoist

Louis E. Emerman & Co., 1761 Elston Avenue, Chicago Ill., have placed on the market the Universal Electric Hoist manufactured by the McCollum Hoist & Manufacturing Co. The hoist will operate interchangeably on single-phase alternating current or on direct current. It can be plugged into a lamp socket in a 110- or 220-volt line.

The hoist is equipped with a limit

"McCollum" Universal Electric Hoist

stop to shut off the current when the hook has reached its upper limit of travel. The limit operates with a hook on either end of the chain. Since the hoist does not need any holding or lowering brakes, hooks can be placed on either or both ends of the chain. The hoist is being supplied in two load capacities.

The 1,000-lb. model has a no-load speed of 22 ft. per minute. With 1,000 lb. on the hook the speed is 12 ft. per minute. It is claimed that this type will easily lift 1,500 pounds. The 2,000-lb. capacity type has a no-load speed of 11 ft. per minute. With full load on the hook, the speed is 6 ft. per minute.

The minimum headroom required for the hoist is 11 in. The weight, complete with 12 ft. of chain and one hook, is 95 pounds.

Trade Catalogs

Brass. The U. T. Hungerford Brass & Copper Co., 46 North Sixth St., Philadelphia, Pa., has published a folder announcing the removal of the Philadelphia warehouses to new quarters.

Circuit Breakers, Oil. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. The type MF motor starting oil circuit breakers manufactured by this company are described in leaflet 20292. Such features as the manual operation, indoor service, non-automatic starting position and the automatic running position are pointed out, and the application, operation, construction and engineer's specifications are discussed. Two tables, one showing the ratings for motor starting breakers, and the other listing the motor starting breakers of the type MF complete the leaflet.

Controllers, Electrical. General Electric Co., Schenectady, N. Y. Bulletin GEA-334 describes the variable-voltage control system for gearless traction elevators manufactured by this company. Views of several installations are given in the bulletin to show the general set up of the equipment. The operation and construction of the apparatus is fully described.

Furnaces, Electric. The General Electric Co., Schenectady, N. Y., has issued a booklet containing reprints of several advertisements displaying the heat-treating equipment manufactured by the company. Illustrations of various types of equipment for different purposes are contained in the advertisements.

News of the Week

Economic Development of Country Traced at Congress of Industry in Philadelphia

Progress pictured by series of elaborate tableaux

With delegates attending from every state in the union, representing some six hundred and fifty chambers of commerce, colleges, industrial schools and trade associations, the Congress of American Industry is in session at the Commercial Museum in Philadelphia. The meetings began on Sept. 7 and continued for the next three weeks, two sessions being held on each of five days in the week.

The congress was held under the auspices of the Philadelphia Chamber of Commerce and was planned and executed by the Industrial Relations Committee of that body. The purpose of the congress was to bring together at one meeting those interested in more than an ordinary way in the development of human relations in industry, to the end that ideas and plans might be openly discussed and the more practical of these put into concrete form for the mutual benefit of both employer and employee.

It is the intention of the Philadelphia chamber to incorporate in book form the proceedings of this meeting, this book to be used as the text in the study of economics in many schools and colleges throughout the country.

Educational Exhibit

In connection with the congress there was prepared what was probably the most realistic tableau presentation of industrial progress ever attempted. The large auditorium of the museum was turned into a series of educational exhibits which portrayed the principal factors entering into the economic and industrial progress of the United States from 1776 to 1926. By means of cleverly conceived and well executed tableau scenes the habits and customs of early settlers were contrasted with the development of industry today. The result was a forceful impression of the privileges and advantages offered by modern conditions.

The tableaux represented fifteen year periods of progress, each one stressing the economic development that was more pronounced in that time. Agriculture, shipbuilding, railroading, civil engineering, communication, manufacturing, merchandising and education were all represented.

The speakers for the daily meetings were selected from among the foremost industrial leaders, educators and government officials in the country. Only two subjects were considered each day. An effort was made to cover each subject thoroughly and to include only such matter as would give a general perspective of the whole economic structure of modern industry.

Among the speakers and their subjects were:

"Natural Resources," by Hon. Herbert Hoover, Secretary of Commerce.

"Education," by Dr. Payson Smith, Commissioner of Education, State of Massachusetts.

"The Agriculturist," by L. J. Taber, Master, the National Grange.

"Research," by Prof. Alexander Silverman, head of the department of chemistry, University of Pittsburgh.

"The Publisher," by Walter Drey, *Forbes Magazine.*

"The Chemist," by Dr. Charles H. Herty, president, Synthetic Organic Chemical Manufacturers' Association.

"The Engineer," by Dexter S. Kimball, dean of the College of Engineering, Cornell University.

"Power and Its Distribution," by Guy E. Tripp, chairman of the board, the Westinghouse Electric and Manufacturing Co.

"Illumination," by Dr. William C. L. Eglin, president, Franklin Institute.

"The Financier," by George W. Norris, governor, Federal Reserve Bank.

"Communication," by John J. Carty, vice-president, American Telephone and Telegraph Co.

"Transportation," Gen. W. W. Atterbury, president, the Pennsylvania R. R. Co.

"The Distributor," by Albert L. Salt, president, the Graybar Electric Co.

"Business Ethics," by Howard Heinz, president, the H. J. Heinz Co.

"The Constitution of the United States," by Hon. James M. Beck, former Solicitor General of the U. S.

"Industrial Associations," by John E. Edgerton, president, the National Association of Manufacturers.

"The Employee, His Responsibilities," by Hon. James J. Davis, Secretary of Labor.

"The Employer, His Responsibilities," by Charles Piez, chairman of the board, the Link-Belt Co.

"Labor," by William Green, president, the American Federation of Labor.

"Industrial Management," by Henry S. Dennison, president, the Dennison Manufacturing Co.

"Religious Liberty," by Hon. Curtis D. Wilbur, Secretary of the Navy.

"Human Relationships," by Thomas E. Mitten, president, Mitten Management, Inc.

"The Future," by Ernest T. Trigg, president, John Lucas & Co., Inc.

Of particular interest to our group of readers was the address of Dexter S. Kimball on the subject—"The Engineer." Dr. Kimball endeavored to emphasize the important part the engineer has played in the development of modern industry and he laid particular stress on the great assistance that machinery has been in that development.

"When you speak of engineers," he said, "you think of men who build boilers, etc., but as a matter of fact this is not complete. The principal and outstanding feature that the engineer has brought to us lies within three channels. First, what we call labor saving machinery. That is, machinery to enable us to do things we can not do with our hands fast. A long time ago we used the winds and tides and now the steam engine and gas engine. It is very interesting indeed to mark the progress in labor saving machinery. Before you were born there was an exposition held here and the most remarkable engine was the Corliss machine by the Curtis Co. The President of the United States turned on the steam. Today we are building turbines with 5,500 horsepower in a single unit, and 7,500 in an assembled unit. How far we may go no man can tell.

Production Machinery

"The second thread of thought, second kind of developing, is what we call time saving machinery. By this we mean the machines that fill our factories and enable one man to do as much as several men did before. How far we may go in time saving machinery again we can only guess. We can not assume the size to which we will carry these machines. I do not know what the largest boring mill was at the time of the Centennial, but I do know there were some 30 ft. in diameter. Today the largest machine can bore 60 ft. How far we may go in automatic machinery puts up some speculation.

"The third important line of work that the engineer brought forward is what may be called transmittal of intelligence—the telephone, telegraph, radio, etc. We have the telephones and radio and telegraph that tend to speed up the whole industrial structure so that with these three senses of thought and development coming along we have accelerated the whole production. How far we may go is also a great speculation."

Taking up another trend of thought, Dr. Kimball said: "There is another contribution engineering is making that is even more important and that is in the field of economics. I do not mean in the sense you had in college, but I refer to economics of industry. The first is the thing we call mass production.

"The American people have developed as no other group has developed and have shown very clearly in the general

way that as the quantity is increasing, cost can be lowered.

"There is one other that has come out of engineering—the modern philosophy of industrial management. Until recently there was no such thing as the philosophy of industrial management, so we see an entirely different phase of the matter. Not all of this has come out of engineering because it did not follow engineering. Do not misunderstand me, I am not talking about financing enterprises—I am talking instead about production—but I can go farther, and there is one other important thing that I want to leave with you.

"Since the development of machinery by engineers, we are told that as the quantity increases the cost can be lowered. You have in this country today mass production in many lines of work, with which we have raised our standards of expectation in this country to the point where the criterion exists that every girl shall have silk stockings and every man own an automobile. That thing rests almost entirely upon mass production, but the economics of that thing are not fully developed."

Power and Civilization

Decentralization of industry appears to be inevitable, declared Guy E. Tripp, chairman of the board, the Westinghouse Electric and Manufacturing Co., in his address which dealt with the extent that power has contributed to the industrial success of the nation. Mr. Tripp said that power distribution will prove a godsend to humanity and to industry by replacing the factory town with a garden community, and thereby improving the living conditions and productive capacity of workers. Part of his address follows:

"Waterpower increased the prosperity of the nation because it was more productive than manual labor; steam power caused a further increase because it was superior to waterpower; and electricity has still further added to our national wealth because it represents a marked advance over directly-applied steam power.

"It has greatly increased the production per worker; it has multiplied our resources by permitting us to accomplish many things that were formerly impossible; it has improved transportation facilities, both urban and interurban; it has transformed our cities into veritable fairylands; and it has raised the standard of living to unprecedented levels. Its use has, in fact, enabled the United States to gain the industrial supremacy of the world.

"The motor vehicle is also proving of the utmost value to the industrial worker. It is saving him an incalculable amount of time in getting to and from work, in receiving supplies, and in delivering finished products; and since much of the time thus saved is being devoted to production, our national wealth is being still further increased.

"There is nothing novel in this, however. Every new application of power does the same thing. What is novel about the automobile is that, in marked contrast to the railroad, it is a decentralizing agency. To it, almost all points, whether urban or rural, within its radius of operation are of equally easy access. It can go and it can collect and deliver almost everywhere.

"Power is, of course, essential to industry, and in the past, manufacturing enterprises have tended to concentrate at points which offered, along with other advantages, opportunities for securing abundant supplies of either fuel or reliable electric power. Under extensive superpower development, however, power will be widely distributed, and industries will be free to locate almost anywhere.

"There are, as a matter of fact, many pressing reasons for the removal of industries out of congested districts. Rent and taxes can be reduced, living conditions for employees can be improved, discipline can be better maintained with less hardship to the individual, and raw materials can often be secured more readily. There is a widespread opinion among industrial men that the concentration of manufacturing in large establishments has gone altogether too far; and, save in the case of certain industries which require the presence of large forces at one point, the typical factory of the future is likely to contain less than 3,000 or 4,000 people, with perhaps only a few hundred as an average.

"The splitting up of large factories into numerous small units is made practicable by the recent advances in standardization and the interchangeability of parts. No longer is it necessary for every part of a machine or utensil to be made at one spot so that all can be fitted properly into the finished product. Standardized parts can now be made in quantity anywhere and assembled anywhere.

"Given, therefore, economic pressure to decentralize, and means for its accomplishment in superpower, automobiles, and standardization, the ultimate result appears to be inevitable."

In discussing "Transportation," A. J. County, vice-president of the Pennsylvania R. R. Co., who read Mr. Atterbury's paper, stated that the material fabric of established civilization is systematic production and exchange, or distribution to consumers, and good credit to mobilize them all. But adequate transportation, he stated, constitutes part of the necessary groundwork for the initiation and sustenance of any form of civilized life.

The paper traced the growth of the nation's transportation facilities, both on land and water, and devoted no little attention to the recent growth of motor transit facilities in competition with rail lines. Statistics were quoted to show the remarkable growth of railroad traffic in the past decade and other proofs were submitted to prove the contention that the railroads have provided one of the greatest aids in the industrial progress made by the nation in the last century.

Mr. Edgerton, in his address, traced the growth of trade unions, commerce associations and trade associations and endeavored to show how this co-operation of thought and effort has added to the better relations existing today between employee and employer.

"Distribution" was given as the greatest and most difficult problem facing the present and the next generation. In his address Mr. Salt laid great stress on the necessity of getting merchandise from where it was to where it was needed and wanted. His was a keen analysis of sales and market conditions and the problem of future developments along those lines.

Papers at Railway Foremen's Convention Stress Economy in Repair Work

Abstracts of several of the more important discussions

The papers presented at the twentieth annual convention of the International Railway General Foremen's Association, held in Chicago, Sept. 7, 8, 9 and 10, covered a range of topics that are becoming more important in the field of railroad operation. Realizing that the efficiency and economy of repairs to locomotives and rolling stock places a great responsibility on management, several of the papers took up phases of shop work and the discussions that were invited brought out some very practical and valuable ideas on the subjects. Repairs, purchase and storage of supplies, maintenance, and foreman training each received particular attention.

A few of the more important papers are presented here in abstract form.

In his paper, "Balancing of Shop Sub Department," F. S. McCarthy said in part: "Every shop has efficient maximum and minimum forces under which repairs can be made economically. Ordinarily, a shop should have a turnover of from 1.5 to 2.5 locomotives for classified repairs, per pit, per month. With this figure, the average minimum and maximum forces should be determined. A valuable adjunct in maintaining a proper shop balance is the adoption of a scheduling system, not too elaborate, but enough so that it will indicate the department that is delaying production. It is surprising what a simple scheduling system will do to increase production, not to mention the friendly enthusiasm created among the supervisors.

"A shop that is working under a piece-work or bonus system has a great many advantages over a shop that works under the day-work system. Such a system will aid in determining any unbalanced condition, since it will indicate the departments that produce to the schedule and those that fall short. Another contributing factor in maintaining proper relations between shop departments is the specializing of work so that men are required to take care of one class of work. In this way, they soon become specialists in that line with the result that the work is performed better and quicker."

In describing the unit spot system of freight car repair as used in the B. & O. shops, A. H. Keys said:

"The sub system of freight-car repairs provides a unit force composed of a foreman, an assistant foreman, and 53 workmen who are employed on designated tracks in the shop, or on shop-yard repair tracks where heavy repairs or building of equipment are handled. This force is required to take care of heavy or rebuilding repairs at a minimum of 15 box cars per week. Bulletin boards representing the cars undergoing repairs are placed at both ends of the tracks on which the unit force is working. Immediately after men have checked in, the foreman indicates in the column under 'working' the number of men reporting for work.

"The advantage of the system is the uniformity of practice maintained, whereby workmen are definitely located at one spot to perform one kind of work. The system further provides maximum safety for the workman since his work is done on a designated spot where the required facilities and material are placed, making it unnecessary for him to collect tools and material from scattered points in the shop."

R. J. Farrington in his paper, "Development of the Mechanic," said:

"There are three classes of apprentices: The regular apprentice of first class, composed of boys seventeen years of age who have had at least one year in high school; the second class, or the helper apprentice, who has had at least two years as a helper in the trade he is going to follow; and the third class, or the special apprentice, who has been college trained and wishes to follow railroad work by acquiring a knowledge of practical shop work.

The Formative Stage

"I believe the regular apprentice makes the best mechanic if properly trained and instructed in the trade, because he comes into the work at a time in his life when influence will go farthest toward determining his career. The boy who is made familiar with the principles of the locomotive and who is given instructions as to fundamentals of its construction and operation is sure to find his work more interesting than the boy to whom these things are a closed book.

"It is important to transfer each apprentice from one department to another, or from one operation to another, at regular intervals so that he may become experienced in all the work in his respective line. While in the department, he should be properly instructed by either the foreman, or the regular instructor, to operate or perform all the work assigned to him."

F. M. A'Hearn in his paper, "The General Foreman's Responsibility for Material Surplus or Shortage," brought out the danger of having surplus material on hand. In part the paper read:

"The office of the general foreman in the railway shop is, to a certain extent, an auxiliary to the purchasing and stores department. The general foreman's position is such that he is enabled to help or to hinder the efforts of the stores department in giving satisfactory service by having necessary materials on hand at all times without having an accumulation of slow-moving or obsolete material.

"As to material shortage, each and every foreman knows only too well the cost of shop delays brought about by the inability to secure material when needed. The desired position and relations between the mechanical department and the stores department is a quick turnover of materials from the stores-department interests, and an ample supply of materials at all times subject to the demands of the mechanical department. To bring this condition about, it is necessary to co-operate in the fullest manner with the stores department in reducing their material inventories by disposing of slow-moving materials.

"Standardization of parts cannot be emphasized too strongly. Probably no other action taken by the mechanical department will assist the solution of the material problem more than this one.

"The use of modern repair methods in the application of long-service materials to various wearing surfaces is recommended. A decided variation is found in shop practices in the matter of estimating wear limits to locomotive parts.

"Locomotive and car department foremen by assuming their share of responsibility for material surplus and shortage can effect savings in many ways. Shop delays, unnecessary items, inactive stocks, obsolete parts, and serviceable materials being lost as scrap can all be lessened through their efforts."

Foreman Training

Some good points were brought out by J. R. Leverage in his paper, "Developing Railroad Shop Foremen."

"There is a wide-spread belief that foremen are born, not made. This belief is but half true, but were it wholly so, it would only emphasize the necessity for greater care in their selection. But is it any more true that good foremen are born, not made, than good mechanics, good doctors, good lawyers and good salsemen, are born, not made?

"The foreman should heve knowledge of the work he is to supervise, but mechanical ability alone is no guarantee of his success. He must have tact and diplomacy, be able to create friendly relations, and command the good will and respect of all with whom he comes in contact, and to inspire his men with joy and pride in their work. He must be able to delegate certain work to others, must guide and watch his men, but not be so busy with routine work as to lose sight of the larger, more important phases of his work. He must be able to co-operate with the management, with his immediate superior, and with other foremen. He should also have good health and physique, and be a man of good moral character.

"There is a great field for training in regular meetings of foremen of departments having similar aims and purposes, similar difficulties and problems. Such meetings if rightfully conducted are fruitful of excellent results. Much depends on the ability of the chairman to draw out his men, to get them to think intelligently, and to express themselves without fear of rebuke or ridicule.

"It is well to submit to men under training a series of questions to study and answer. Such questions will teach them to think and observe, greatly broaden their knowledge, and increase their usefulness. Prospective foremen should also be encouraged to read and study railway and trade magazines, also trade catalogs descriptive of machinery and materials.

"One of the best means of developing railroad shop foremen is a modern up-to-date apprenticeship system. This plan not only serves to supply the road with competent mechanics for the rank and file but incidentally prepares desirable material for official positions. The graduates are skilled mechanics with an all-around training. Their four years attendance in apprenticeship school develop their mental power and instills in them the habit of studying and reading. Their knowledge of drawing enables them to read blueprints readily and to make intelligent sketches when desired."

In his paper, "Modern Shop Equipment as a Factor in Increased Production," by H. W. Harter, was the following:

"The problem of modern shop equipment is one that concerns everyone and becomes more important each year. The increased competition for transportation, with the progress made in locomotive design, controls to a great extent the use of our present equipment for future production.

To properly analyze the conditions that show the saving of modern equipment, the following procedure was submitted:

"Study the old method of performing the operation closely, and determine if by certain changes or additional tools the job can be improved. Compile figures showing the actual output of the machine, for comparative purposes. Another vital factor that arises is the maintenance of the old machine, and the quality of the work being done.

"In purchasing the new machine, correct and definite specifications should be submitted. It is essential that your contemplated output for this machine is properly estimated. The machine should not be too highly specialized, which would be a handicap during a decrease in production, and result in the machine being idle when it should be used for other purposes. After the machine is properly installed, the operator should be instructed to obtain the highest point of efficiency."

Welding Society to Meet in November

The fall meeting of the American Welding Society will be held in Buffalo on Nov. 17, 18 and 19. An International Welding and Cutting Exposition will be held in connection with this meeting and will open Nov. 16.

The technical sessions include railroad, welding apparatus, welding science in the engineering curriculum of universities, and welding in a gaseous atmosphere. The entertainment includes a trip to Niagara Falls, a view of the Falls from the American side, with an inspection trip through the Niagara Falls Power House, a buffet supper on the Canadian side and a special illumination of the Falls.

The Business Barometer

This week's outlook in Commerce, Finance, Agriculture and Industry based on current developments

By Theodore H. Price
Editor, *Commerce and Finance, New York*

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THE chorus of prosperity that is to be heard nearly everywhere is still harmonious for the pessimists, if there are any, are not lifting up their voices very loudly. Nor are the prophets of business recession who sometimes cry in the wilderness much in evidence. They can discover no excesses to cry against, and lacking a target they are probably wise in keeping their own counsel. This is said with the knowledge that installment buying is thought by some to be of orgiastic proportions, but the observant have noted that some of its excesses are already being restrained and to assail the practice on economic principles is much less fashionable than was the case a year or so back.

As for the speculative land and security booms that justly caused alarm not long ago, they are dying away without creating much distress.

Therefore the business world upon the whole is sanely enjoying the abundant autumnal activity and is planning for the future with a conservatism that ought to assure good times for some months to come. The weeks are slipping by uneventfully, and since the unexciting is also the most stable the relative dullness of the business news ought to be a source of satisfaction to everyone except perhaps the newspapers.

But of course complete stability is impossible and most of us realize that there is now less room to move upward than downward, and that as the law of change gets in its work, a drop in the level of activity is practically unavoidable. Therefore it is wise to watch the building statistics, the money market, the automobile industry and crops and crop prices for weather indicators. The building statistics are a little ambiguous in that some deal with permits and some with contracts, but the decline in contemplated residential construction is undoubted and it seems to be only partly offset by the engineering projects that are so numerous and large.

The money markets hold their recent advances but credits are in ample supply and the seasonal firmness in rates is not sufficiently impressive to raise expectations of a business storm from that quarter although it signals caution.

The automobile industry, according to its own reports, is enjoying one of the best fall markets in its history and while its prosperity is not evenly distributed by any means, its leaders look for a satisfactorily large production during the next three months. But that the marks of the early part of this year can be equalled is virtually impossible.

How greatly the automobile business has supported American prosperity is demonstrated by figures just prepared by one company, which show that in addition to the 151,000 employees on its rolls (not including certain affiliated companies or its 20,000 dealers and their employees) and the 45,800 stockholders to whom its dividend checks are mailed, it buys material and supplies from no less than 6,000 concerns and does business with 12,500 banks. When such a powerful mainspring is wound up, its driving force is felt in every town of size in the country.

As for the crops it is impossible to count them until they are harvested, but they improved during August and upon present indications and present prices the farmers will have enough money to make fall buying "as usual," though their cash return may possibly fall below last year.

The composite of these essential elements in the business picture seems to justify contentment but not complacence, for when the early part of 1927 comes to be compared with the corresponding months of 1926, the showing may be slightly unfavorable. Then the hare may be forced off the road while the tortoise overtakes him. Meanwhile everyone who wants work has it and no reason exists why holiday business this year should not break all records.

Of the week's markets it can be said generally that they confirm the tendency of commodity prices to recover from their long decline. One of the conspicuous exceptions was cotton; the growing crop has had good weather and larger estimates of the yield are currently accepted. But cotton goods are comparatively firm and the more profitable margins that spinners are now obtaining seem to assure an increase in mill operation and an active fall. The same prediction holds good for the woolen and silk mills, for the textile industry is indubitably recovering from its slump and in those two branches the raw materials have been advancing also.

Sugar has continued firm on evidence that the country's requirements are of record size and stocks rather low, while the expected decree prohibiting grinding of cane in Cuba before Jan. 1 will transform the prospective small carryover at the end of the year into a possible deficit before new crop sugar is ready.

Rubber is very quiet but speculative interest seems to favor the bull side.

In industry it is already possible to estimate what the year's record will show. Iron and steel output will be greater, as will production of textiles. At least as many automobiles will be manufactured and the total of building construction will be little less. The trade activity centering about these four leading industries reaches every hamlet and their disbursements for wages and materials are all the assurance of business that is needed.

What's Doing in Industry

Industrial activity on a large scale throughout the country is being reflected in the upward trend of sales in machinery and machine tool lines. Earlier predictions of good fall business are being borne out by the present volume of orders, and the inquiry mail brings additional evidence of continued activity in the weeks ahead. Business is scattered and, while no large orders or lists are on record, there is a substantial volume of small business that makes a fair total for this season.

A slight gain in sales is reported from Detroit, where the trend of present business indicates a good fall season. Business is quiet in Chicago, the volume of actual sales being below expectations but the inquiries pending are expected to open up after the machinery exposition.

Cincinnati reports a continued improvement in sales, with an export inquiry promising some nice future orders. Renewed activity in Indianapolis has brought a spotty demand for miscellaneous equipment and the outlook is much better.

The New York market reports nothing startling, business going on at a normal pace. In New England many machinery manufacturers are working to capacity and dealers are optimistic over the trend of present business. Industrial activity in Canada has increased and has afforded much in the way of contracts for industrial machinery.

The chorus of prosperity that is to be heard nearly everywhere is still harmonious. The business world is sanely enjoying an abundant autumnal activity and is planning for the future with optimism and conservatism.

The Industrial Review

Progress of the machinery and machine tool business in various parts of the country

THE following reports, gathered from the various machinery and machine tool centers of the country, indicate the trend of business in these industries and what may be expected from the future:

Cincinnati

The prevailing opinion in the Cincinnati machine tool trade is that while September has so far come up to expectations, with sales that exceed those of the corresponding period of last year, it is not going to prove to be a peak month, as has been the case in some years.

Business continued on the up-grade in the past week, with an increased number of inquiries coming in, which lead to the belief that the demand for all kinds of machine tools will keep on increasing in a normal way for some time to come.

While the greater part of the week's sales consisted of single tools and replacements, more than a few fair-sized orders were received. One export order called for a little more than $55,000 worth of tools, to go to Russia, and several more foreign deals are said to be near the point of closing.

Orders booked in the week came from all sections of the country, the majority of them coming from general machinists and industrial users and calling for single tools and replacements. The purchases were well diversified as to sizes and types and they were well distributed geographically.

Concerns in the automotive industries did more buying than in the previous week and sent in an increased number of inquiries, but no large orders are reported. Railroads still confined their orders mainly to single tools and replacements, but the aggregate purchases from this source were larger than in the previous week. Some manufacturers have increased their output slightly and all expect greater manufacturing activity to follow as the fall advances.

New England

Practically every line of the machinery industry in the New England territory is enjoying good business, according to the opinions of leading manufacturers. Generally speaking, the companies have orders booked which will carry them on to the end of the year and in some instances well into next year. The year will finish, according to present expectations, much better than last year.

The demand for machinery is very general, representing all classes of industry—automotive, electrical and railroads being the outstanding lines. Domestic business continues good and there continues to be an improvement in the export trade.

Manufacturers are adding to their working forces. In Hartford machinists are being hired as fast as they present themselves, and employment shows about 10 to 15 per cent increase over a year ago at this time. Working forces in New Britain are also being increased. Bristol and Waterbury companies report employing additional help.

Indianapolis

A renewed activity in machine tool and machinery trade here, particularly as regards inquiries, has made the local trade rather optimistic. The actual demand continues somewhat spotted, but the soft spots gradually are being ironed out and by the end of the present month the trade is expecting some real business. Surveys made in Indiana of industrial conditions show an improvement after the usual summer lull.

Perhaps one of the most encouraging features is the continued demand for construction machinery, both for road work and for big building construction. Usually at this time of the year this demand slumps noticeably. Dealers in construction machinery say they have had one of the best seasons in their history. And next year is expected to be even better.

During the last two weeks there has been a big volume of inquiries from the coal fields for special mining machinery. These are expected to result in business. Most of the mines have reopened and new fields are being developed. A big demand continues for brick making machinery.

The tool demand from the automobile factories is good, with Indiana factories increasing production for fall business, but the machinery demand is not so good. The demand for wood-working machinery for furniture and wood-working factories continues good and the same is true of the agricultural implement factories, most of which are speeding up production. Special equipment for garages and cylinder grinding shops is moving better than usual at this season.

New York

Business in machinery and machine tools in this market continues at a fair rate. Indications are that September will prove a better month in total sales volume than August. Inquiries have not dropped off to any extent, but there have been no large lists received by local dealers and agents. Most of the present lists call for single machines, which would seem to indicate a replacement market.

Automobile manufacturers were active last week, small orders having been received from Chrevolet, Pontiac and Dodge. Other buyers were the Eastern Machine Co., the Detroit Lubricating Co., the Timken-Detroit Axle Co. and the New York Central R.R.

The second-hand market experienced a slight improvement in the past ten days. More than one good sized order was placed and the machines included: Four 16-in. geared-head lathes, two 13-in. geared-head lathes, 4 jig borers, a grinding machine and a vertical shaper.

Detroit

Sales of machinery and machine tools in Detroit and surrounding territory show a slight gain that indicates better business for the remainder of the year. Whereas the summer months can best be described as only fair, machine tool agents regard prospects as much better for the immediate future. Orders received by Detroit firms during the past week were well scattered and came from practically all industries. Automotive plants remain as the largest buyers. Purchases, generally speaking, have been confined to single tools for replacement purposes. Automobile companies from whom little had been expected in the way of new business during the last half of the year, as compared with the last six months of 1925, are buying more tools than for some time and the pessimistic outlook which some manufacturers took two or three months ago seems to be dissipated.

Railroads are sending out some lists of tools, while sales to general machinists and industrial users of machine tools show an increase.

The General Motors plants remain the heaviest buyers of new equipment. Cadillac is ordering new machinery for models expected to be introduced the first of the year. Chevrolet is requiring much in the plants which are being constructed and expanded.

An encouraging factor which machine tool dealers point to as forecasting better business during the last quarter of the year is the steady gain in employment figures in Detroit plants, which employment is now the highest for any time during the past ten weeks.

Chicago

Business in machine tools, both new and used, is quiet. September has not produced the demand looked for by dealers. As compared with the first half of August, there has been a falling off in the volume of sales, and a somewhat lessened number of inquiries. In certain lines, particularly in electric tools, the demand continues good, with no indications of slackening in the immediate future.

Dealers in used tools report trade as indifferent, with the exception, however, that there are many inquiries for tools they are unable to supply or to obtain, among which are high-speed drill presses, millers of a certain type, and crank shapers.

Neither the railroads nor the automotive industry are factors in the present market, such buying as they are reported to be doing being limited to single tools or small lots. A number of machinery men express the belief that the steel and machine tool exposition will serve as a trade stimulant, stating that many prospective buyers are holding off closing until the exposition is over.

Canada

Manufacturers of machinery and machine tools in Canada report a marked increase in demand during the first two weeks of September. The electrical supply, pulp and paper, and automobile industries are now placing orders, while considerable new business is expected to develop as a result of increased operations in agricultural implement and machinery plants.

The outlook for the steel industry during the remainder of the year is considered to be excellent. There is every indication of an indefinite continuance of the activity which made the two midsummer months stand out so far above the July-August average for several years. Both mill operations and prospective demand are favorable. Engineering shops are reported to be fairly well booked with fall business of a diversified nature, and reports are current that some new railroad business will soon be released.

The Algoma Steel Corporation started recently on an order for the Canadian Pacific Ry. which will keep the mill operating on single shift for several months. The Dominion Alloy Steel Corporation has decided to increase its capacity to 1,000 tons per month and installation of the necessary equipment will commence at once. The company reports that its plant is operating 24 hours per day.

The high rate of automobile production continues, with a highly satisfactory increase in demand.

Due to the unusually heavy building and construction program throughout the Dominion, wholesale hardware houses look to fall business with the utmost confidence. Dealers report that fall goods in this line are already moving in splendid volume.

New Program in France to Cut Living Costs, Build Exports and Limit Imports

Demand for industrial machinery is increasing

By Our Paris Correspondent

Monsieur Caillaux is reported to have said that Great Britain was ruled by her financiers and France by her industrialists. This being so, France is still looking to her industrialism to save the situation. This may be a circumscribed industrialism along luxury lines and some other specialties, but the sum total of receipts therefrom may well be considered an important factor in the hoped for French revival. It is without question that the temporary financial situation has improved; the doubt lies as to the possibility of its continuance.

France on the armament question at Geneva and her controversy with Spain over the Tangiers problem is once again throwing herself headlong against world opinion. Between now and the end of the year there will be a shaping up of the situation, doubtless to the benefit of France, when there may be released a wave of encouraging prosperity which for the moment the powers that be only hint at. If it does not come what may happen in 1927 will prove a greater damper in the revival and stabilization of things French than anything that has occured since the outbreak of the war.

The new government program of reorganization comprehends an effort to cut high living costs, build up exports and cut down imports, economy of administration expenses by suppression and compression of public services and the formulating of a new budgetary system for years to come.

The French State Railways have borrowed 250 million francs at 7 per cent, the sum to be used for the procuring of new equipment which, if French rolling stock and motive power plants can supply on better terms than Germany, they will benefit.

Imports Increase

The *Journal Officiel* announces the fact that exports for the first seven months are stationary, corresponding to those of the same period of 1925—28 billion francs. Imports, however, have increased from 19 billion francs to above 30 billion francs, those from the United States increasing from 3,381,378,000 francs to 4,482,206,000 francs, a billion or more increase, for the major part of which France has got to find dollars at something like thirty-five francs each to liquidate, as exports to the U. S. A. have increased but little.

Considerable concern is shown in government and financial circles over the drop in exports for the first half year—2½ billion francs below imports, while in 1925 they exceeded imports by a like amount, which leaves a foreign trade deficit for the year of 5 billion francs. It is a stated part of the Poincare program to build up exports, but just how is not defined. Dumping would be a fatal policy in the long run with so much raw and semi-raw material coming from abroad.

Aluminum and copper imports show the justness of the above claim as per the following figures:

	First six months Imports into France 1926	1925
Aluminum Stampings, Wire and Ingots, kilos	890,500	181,900
Valued at, francs	6,557,000	3,442,000
Copper, kilos	79,344,700	60,816,500
Copper, francs	682,005,000	358,994,000

Imports of machinery, etc., for the period Jan. 1 to June 30 for the present and last year totalled as follows:

Prime movers, steam and other, tons	80,197	70,777
Prime movers, francs	787,050,000	493,204,000
Boilers, tons	2,514	2,980
Boilers, francs	10,884,000	8,861,000
Machinery and parts, tons	10,154	10,794
Machinery and parts, francs	169,402,000	116,323,000
Tools, etc., tons	21,396	21,271
Tools, etc., francs	231,868,000	174,746,000

Exports from France during the same period:

	Six months of 1926	1925
Prime movers, steam and other, tons	61,578	50,726
Prime movers, steam and other, francs	515,899,000	346,486,000
Boilers, tons	4,876	3,555
Boilers, francs	27,243,000	211,290,000
Machinery and parts, tons	36,575	32,099
Machinery and parts, francs	290,048,000	205,353,000
Tools, etc., tons	343,365	243,873
Tools, etc., francs	1,375,998	744,240,000

Sales of both French and foreign agricultural machinery have increased during the present year fully 25 per cent and French manufacturers are making plans for still greater output the coming season. Most industrial machine tools are increasing in demand, those of American origin being no exception; there is even a growing demand for second-hand machine tools, largely induced by the high prices of new units. The falling franc has had a reaction on the import of American automobiles and for that matter has slowed down sales of the home product, which in many cases equal the imported article in price.

The metal fabricating trades are much concerned as to where specialized workers are coming from in the future owing to the apprenticeship crisis which is growing more acute rather than improving as to conditions. A School of Metal Trades has been inaugurated to teach the young worker that he must work with both brain and hands and that he must understand the means by which tools and machinery may be made to give their best and fullest capacities.

The situation in the French automobile industry is characteristic of that which applies to other metal and machinery trades. The industry in France is by no means as efficiently equipped as in America; its fabricating, transforming and overhead costs are proportionately greater, but its raw and semi-raw materials to a large part cost less owing to the depreciated franc with which they are paid for. It is not because the French workman is a rapid worker, for he is far below the American in this respect, and whatever his potential intelligence may be he is on all counts a less capable worker—the labor charge is thus inordinately large.

The real crisis in this industry when, or if, it comes will be fatal to the less efficiently equipped small plants which can in no way expect to compete with Renalt, Citroen and Peugeot, who with the Italian Fiat (working so largely with American capital and above all with the perfection of American machine tools) have the bulk of the French market. The big production plants will represent, if not the survival of the fittest, at least the demonstration of what may be considered the only successful method of operating.

It may be said that the same conditions apply to the production of other competitive commodities made in what the French call "series"—en masse.

Drafting-Room Practice Subject for Study by Engineers

As a result of the preliminary conference held by the American Engineering Standards Committee, a sectional committee is being organized by the American Society of Mechanical Engineers and the Society for the Promotion of Engineering Education, under the procedure of the American Engineering Standards Committee, to formulate national standards for drawings and drafting-room practice. The scope of the committee's project is given as

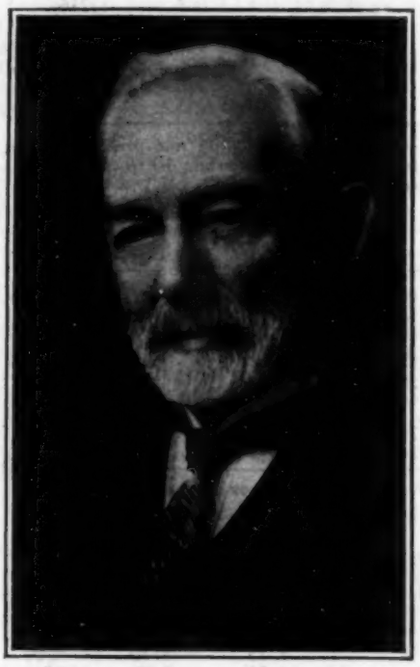
> The classification of and corresponding nomenclature for drawings in accordance with their purpose; method of representation of the subject, including arrangement of views and sections; use of lines of different kinds and thicknesses; indication of dimensions, tolerances and fits, tapers and slopes, and surface or finish; symbols for elements; indication of materials by cross-hatching; arrangement of border-line, title, part list, notes, changes, and revisions; method of folding and punching; kinds and sizes of lettering, figures and symbols; scales of reduction and enlargement; sizes of drawings and filing cabinets; width of rolls of paper and cloth; size of drafting equipment and tools, and specifications for materials to be used for drawings and drafting.

Probably much can be done with regard to standardizing such items as sizes of drawings and tracings, cross-sectioning and practices that are not governed principally by the requirements of individual firms. A preliminary survey of items included in the scope of the committee's work indicated in many cases a notable lack of uniformity in practice, standards for which are possible and desirable. The reports of the committee when formulated and issued should be of widespread interest inasmuch as every manufacturing company will probably be able to adopt at least some recommendations to its advantage.

G. I. Alden, of Norton Co., Died at Worcester

George Ira Alden, chairman of the board of directors of the Norton Co., Worcester, Mass., died at his home in that city on Sept. 13. Mr. Alden was 83 years old.

In the field of mechanical engineering, George I. Alden had attained a most influential position. He began his career at the Lawrence Scientific School, and later won the degree of mechanical engineer from Cornell University. In 1868 he was called to Worcester Polytechnic Institute where he remained as teacher of engineering until 1896, being head of the mechanical engineering department for twenty-eight years. During that time he built and equipped three laboratories—engineering, power and hydraulic testing.



George Ira Alden

When the Norton Co. was incorporated in 1885, Mr. Alden became a member of the firm. He served successively as treasurer and president, and at the time of his death was chairman of the board. Mr. Alden was a member of the Engineers' Club and the American Society of Mechanical Engineers.

Obituaries

WILLIAM HERBERT GATES, founder and treasurer of the Baldwin Chain and Manufacturing Co., of Worcester, Mass., died on Sept. 16 at his home in Princeton, Mass.

VERNON F. PRENTICE, long connected with the Prentice Brothers Co., of Worcester, Mass., in the manufacture of lathes, died Sept. 9 at his home in that city. Mr. Prentice was 87 years old and a native of Worcester, where he learned the machinist trade when a young man. He was one of three brothers, Benjamin, Albert and Vernon, who organized the Prentice Brothers Co. Mr. Prentice retired from active work as a manufacturer some years ago.

Business Items

The American Crucible Products Co., of Elyria, Ohio, announces the removal of its general offices and manufacturing plant to new buildings at Lorain, Ohio.

The Hanson-Van Winkle Co., manufacturer of electric plating and polishing equipment, has purchased the plant of the Atha Steel Works in Newark, N. J.

The Chicago Granitine Manufacturing Co. has selected a site at 3030 Huron St., Denver, Colo., and will establish a branch plant. A. E. Minardi, of Omaha, will be in charge of the new factory.

The Grant Sales Co., of Minneapolis, Minn., representative of the Fibroc Insulation Co., manufacturer of Fibroc-Bakelite, has moved to new and larger quarters at 1004 Marquette Ave.

The Chrobaltic Tool Co., of Detroit, has just completed the construction of a modern foundry, especially designed for the manufacture of heat-resisting and special alloy castings. This new shop is located in Michigan City, Ind.

Joseph Hyman & Sons, dealers in new and rebuilt power presses, have moved into a new plant at Tioga, Almond and Livingston St., in Philadelphia. The new shops afford greater facilities for repairing and testing presses and for meeting urgent service requirements.

The last stage of the $3,000,000 electrification program of the Inland Steel Co., Indiana Harbor, has been begun. The 24-in. bar mill, the bloomer mill and the sheet bar mill and eight open hearths in Plant No. 1 have been closed in order to set up generators and other electrical equipment. All departments are to be electrified.

The Winchester Repeating Arms Co., New Haven, Conn., has acquired the George W. Dunham Co., of Utica, N. Y., manufacturer of washing machines. The latter company will retain its individuality, George W. Dunham continuing as president and James McClymont as sales manager. The company will be moved to New Haven and the washing machines manufactured there.

The Auburn Automobile Co., Auburn, Ind., will build its six-cylinder automobiles at Connersville, Ind., according to an announcement of E. L. Cord, president and general manager. The four and eight cylinder cars will be made in Auburn. Plans are being made to build 25,000 motor cars next year. The executive offices will be continued in Auburn and the present force of employees will be kept at work.

Further expansion of the United States Steel Corporation in the Calumet district of Indiana has been announced. A 50-per cent increase in the American Sheet and Tin Plate plant during the next fifteen months, to cost nearly $9,000,000 will be made. Later the corporation will increase its Gary plant capacity. The plant was established in Gary at a cost of $15,000,000 and employs between 3,000 and 4,000 men. The tin plate plant has been running at capacity throughout the summer.

Reorganization of the general engineering department of the Westinghouse Electric and Manufacturing Co. has been announced by H. W. Cope, assistant director of engineering. The reorganization has necessitated the re-allocation of several engineers, four being elevated to managers of engineering. These are F. C. Hanker, manager of central station engineering; S. B. Cooper, manager of railway engineering; G. E. Stoltz, manager of industrial engineering; and W. E. Thau, manager of marine engineering.

P. M. Gelatt, president of the National Gauge and Equipment Co., LaCrosse, Wis., manufacturer of automotive accessories, has announced the disposition of the controlling interest in the business to the Motometer Co. of New York. While the transfer of stock will not affect personnel or policies of the National company, it is stated that the Motometer Co. will add the production of motor heat-recording devices to the present line at LaCrosse, and to accommodate the operation, an addition, 140x160 ft., will be made to the plant. Mr. Gelatt will continue as president of the LaCrosse concern.

Regional Conference on Farm Problems

The attention of agricultural and other business and industrial interests of eight Western states will be brought to a focus upon outstanding agricultural problems of that region at a conference to be held at Salt Lake City, Oct. 1 and 2, under the joint auspices of the Chamber of Commerce of the United States and the Salt Lake City Chamber of Commerce.

This conference will be the first of a series of five to be held this year, embracing 29 states, designed to approach agricultural problems from a regional, rather than exclusively a national angle.

Personals

A. H SKEER, vice-president of the Denver Rock Drill Manufacturing Co. for the past six years, has been elected president. W. H. Leonard, whom he succeeds, has been made chairman of the board of directors.

J. E. MACARTHUR has been appointed general manager of the Abbott Ball Co., of Hartford, Conn. Mr. MacArthur was formerly connected with the Brown & Sharpe Manufacturing Co., the Pierce-Arrow Motor Car Co., and the Russell Motor Car Co.

L. S. HARDING, for several years employment manager and director of training for the Worthington Pump and Machinery Co., East Cambridge, Mass., has been appointed industrial training advisor for the Associated Industries of Massachusetts. He will continue his work with the Worthington organization.

Forthcoming Meetings

American Foundrymen's Association. Second international foundrymen's congress, Detroit, Sept. 27 to Oct. 1, under the auspices of the American Foundrymen's Association. R. E. Kennedy, secretary, 909 W. California St., Urbana, Ill.

National Association of Manufacturers. Thirty-second annual meeting, Waldorf-Astoria Hotel, New York, Oct. 5, 6 and 7. George S. Boudinot, secretary, 50 Church St., New York.

American Institute of Mining and Metallurgical Engineers. General meeting, Hotel Schenley, Pittsburgh, Oct. 5 to 9. H. F. Bain, secretary, 29 West 39th St., New York City.

American Management Association. Fall meeting, Hotel Statler, Cleveland, Oct. 11 and 12. W. J. Donald, managing director, 20 Vesey St., New York City.

American Gear Manufacturers Association. Semi-annual meeting, Briarcliff Lodge, Briarcliff Manor, N. Y., Oct. 14, 15 and 16. T. W. Owen, secretary, 2443 Prospect Ave., Cleveland, Ohio.

American Iron and Steel Institute. Fall meeting, Hotel Commodore New York, Oct. 22. E. A. S. Clarke, secretary, 40 Rector St., New York City.

National Safety Council. Fifteenth annual safety congress, Detroit, Mich., Oct. 25 to 29. A. A. Mowbray, director, 108 East Ohio St., Chicago.

American Welding Society. Eighth annual fall meeting, in conjunction with International Welding and Cutting Exposition, Broadway Auditorium, Buffalo, N. Y., Nov. 16 to 19. Secretary's headquarters, 29 West 39th St., New York City.

The Weekly Price Guide

Rise and Fall of the Market

Sheet mills are getting themselves used to the new bases and differentials. Orders for plates are particularly active in Chicago; the Pittsburgh price is $1.90. Semifinished steel is being signed up for the fourth quarter at present prices. Orders for pipe in August exceeded shipments by more than 10 per cent, which has tied up deliveries and therefore reduced new inquiries.

(All prices as of Sept. 17)

IRON AND STEEL

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	
No. 2 Southern	$24.19
Northern Basic	20.39
Southern Ohio No. 2	21.39
NEW YORK—Tidewater Delivery	
Southern No. 2 (silicon 2.25@2.75)	27.37
BIRMINGHAM	
No. 2 Foundry	21.00
PHILADELPHIA	
Eastern Pa., No. 2x (silicon 2.25@2.75)	22.76
Virginia No. 2	28.67
Basic	21.26
CHICAGO	
No. 2 Foundry local	21.75
No. 2 Foundry, Southern (silicon 2.25@2.75)	25.05
PITTSBURGH, including freight charge ($1.76) from Valley	
No. 2 Foundry	19.76
Basic	19.76
Bessemer	19.76

IRON MACHINERY CASTINGS—Cost in cents per lb. of 100 flywheels, 6-in. face x 24-in. dia., hub not cored, good quality gray iron, weight 275 lb.:

Detroit	5.00@5.50
Cleveland	5.00@5.25
Cincinnati	5.00@5.50
New York	5.25@5.50
Chicago	5.25@5.75

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the mill base in large lots.

Blue Annealed	Pittsburgh Mill Base	New York
No. 10	2.30	3.89
No. 12	2.35	3.94
No. 14	2.40	3.99
No. 16	2.50	4.09
Black		
Nos. 18 to 20	2.80	4.15
No. 22	2.95	4.30
No. 24	3.00	4.35
No. 26	3.10	4.45
No. 28	3.25	4.60
Galvanized		
No. 10	3.15	4.40 to 4.65
Nos. 12 to 14	3.25	4.50 to 4.75
No. 16	3.35	4.60 to 4.85
No. 18	3.50	4.75
No. 20	3.65	4.90
No. 22	3.70	4.95
No. 24	3.85	5.10
No. 26	4.10	5.35
No. 28	4.35	5.60

WELDED STEEL PIPE—Warehouse discounts are as follows:

	New York		Cleveland		Chicago	
	Black	Galv.	Black	Galv.	Black	Galv
1 to 3 in. steel butt welded.	53%	39%	55½%	43½%	54%	41%
2½ to 6 in. steel lap welded.	48%	35%	53½%	40½%	51%	38%

Malleable fittings: Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36-5% off.

Size, Inches	List Price per Foot	Diameter in Inches — External	Diameter in Inches — Internal	Thickness Inches
1	$0.17	1.315	1.049	.133
1¼	.23	1.66	1.38	.14
1½	.27½	1.9	1.61	.145
2	.37	2.375	2.067	.154
2½	.58½	2.875	2.469	.203
3	.76½	3.5	3.068	.216
3½	.92	4.0	3.548	.226
4	1.09	4.5	4.026	.237
4½	1.27	5.0	4.506	.247
5	1.48	5.563	5.047	.258
6	1.92	6.625	6.065	28

SEAMLESS STEEL TUBING—Following net prices are for seamless mechanical tubing, cold drawn, round, .10 to .30 carbon, at warehouse in lots of less than 100 ft.:

Thickness — Decimal	B.W.G. and Fractions	Outside Diameter in Inches ¼	⅜	½	⅝	1	1¼	1½
		Price per Foot						
.035"	20	$0.15	$0.16	$0.17	$0.18	$0.19	$0.21	$0.23
.049"	18	.17	.18	.19	.20	.21	.23	.25
.065"	16	.19	.20	.21	.22	.23	.25	.27
.083"	14	.20	.22	.23	.24	.25	.27	.29
.095"	13	.21	.23	.25	.26	.27	.29	.31
.109"	12	.22	.24	.26	.27	.28	.30	.32
.120" or .125"	11	.23	.25	.27	.28	29	.31	.33
.134"	10	.24	.26	.28	.29	30	.32	34

MISCELLANEOUS—Warehouse prices in cents per pound in 100-lb. lots:

	New York	Cleveland	Chicago
Spring steel (light) (base)*	7.00	6.00@7.50	4.65†
Spring steel (heavier)	4.00	....	4.00
Coppered Bessemer rods (base)	6.05	6.00	6.20
Hoop steel	4.49	3.65	4.15
Cold rolled strip steel	6.25	6.35	6.25
Floor plates	5.25	5.30	5.00
Cold drawn shafting or screw	4.00	3.90	3.60
Cold drawn flats, squares	4.50	4.40	4.10
Structural shapes (base)	3.34	3.10	3.10
Soft steel bars (base)	3.24	3.00	3.00
Soft steel bar shapes (base)	3.24	3.00	3.00
Soft steel bands (base)	3.99	3.20	3.65
Tank plates (base)	3.34	3.20	3.10
Bar iron (3.00 at mill)	3.24	3.21	3.00
Drill rod (from list)	60%	55%	50%

Electric welding wire, New York, 1/32, 8.35c.; ⅛, 7.85c.; 1/32 to ⅛, 7.35c. per lb. *Flat, 1/16@¼-in. thick. †F.o.b. cars.

METALS

Current Prices in Cents Per Pound

Copper, electrolytic (up to carlots), New York			15.62½
Tin, 5-ton lots, New York			67.50
Lead (up to carlots) E. St. Louis	8.65	New York	9.50
Zinc (up to carlots) E. St. Louis	7.40	New York	8.37½

	New York	Cleveland	Chicago
Antimony (Chinese), ton spot	18.00	20.50	17.00
Copper sheets, base	23.00	23.00	23.00
Copper wire, base	20.00	20.00	16.50
Copper bars, base	22.62½	22.62½	22.50
Copper tubing, base	25.00	25.00	25.00
Brass sheets, base	19.37½	19.37½	19.37½
Brass tubing, base	24.25	24.25	23.75
Brass rods, base	17.12½	17.12½	17.12½
Brass wire, base	19.87½	19.62½	19.87½

Shop Materials and Supplies

METALS—Continued

	New York	Cleveland	Chicago
Aluminium ingots, 98 to 99%, 1 to 15 ton lots	27.00	27 00	27 02
Zinc sheets (casks)	13.25	13.05	12.01
Solder (½ and ¼), (case lots)	41.12½	42.00	38½@42½

Babbitt metal, delivered, New York, cents per lb.:

Genuine, highest grade	84.00
Commercial genuine, intermediate grade	56 00
Anti-friction metal, general service	31 50
No. 4 babbitt (f.o.b.)	14 75

Nickel, f.o.b. refinery, cents per lb.:
Ingots..... 35 00 Electrolytic.. 39.00 Shot.....36.00

SPECIAL NICKEL AND ALLOYS—Price in cents per lb., f.o.b. Huntington, W. Va.:

Hot rolled nickel sheet (base)	52.00
Cold rolled nickel sheet (base)	60.00
Hot rolled rods, Grade "A" (base)	50.00
Cold drawn rods, Grade "A" (base)	58.00

Base price of Monel metal in cents per lb., f.o.b. Huntington, W. Va.:

Shot	32.00	Hot rolled rods (base)	35.00
Blocks	32.00	Cold drawn rods (base)	43.00
Cold rolled sheets (base)	50.00	Hot rolled sheets (base)	42.00

OLD METALS—Dealers' purchasing prices in cents per pound:

	New York	Cleveland	Chicago
Crucible heavy copper	12.37½@12.62½	11.50	11.25@11.75
Copper, heavy, and wire	11.62½@12.12½	11.75	10.75@11.25
Copper, light, and bottoms	10 00 @10.37½	10.00	9.50@10.25
Heavy lead	7 50 @ 7.75	7.00	7.00@ 7.50
Tea lead	5.50 @ 6.00	5.00	6.00@ 6.50
Brass, heavy, yellow	7.25 @ 7.50	7.50	7.25@ 7.75
Brass, heavy, red	9.50 @10.00	9.75	9.00@ 9.50
Brass, light	6.00 @ 6.25	6.00	6.75@ 7.25
No. 1 yellow rod turnings	8.25 @ 8.50	8.00	7.75@ 8.25
Zinc	4.25 @ 4.75	4.50	4.25@ 4.75

TIN PLATES—American Charcoal—Bright—Per box

		New York	Cleveland	Chicago
"AAA" Grade:				
IC,	14x20	$12.10	$11.95	$11.50
"A" Grade:				
IC,	14x20	9.70	9.90	9 50
Coke Plates—Primes—Per box				
100-lb.,	14x20	6.45	6.10	7.00
Terne Plates—Small lots, 8-lb. Coating—Per box				
IC,	14x20	7.75@8.00	6.95	7 50

MISCELLANEOUS

	New York	Cleveland	Chicago
Cotton waste, white, per lb.	$0.13@0.17½	$0.18	$0.15
Cotton waste, colored, per lb.	.10@ .14	.14	.12@.17
Wiping cloths, washed white, per lb	.17½	36.00 per M	.15
Sal soda, per 100 lb. keg	2.05	2.25	2.75*
Roll sulphur, per 100 lb	2.70†	3.50	4.25‡
Linseed oil, per gal., 5 bbl. lots	.93	1 05	92
Lard cutting oil, 25% lard, per gal.	.55	.50	.48
Machine lubricant, medium-bodied (55 gal. metal bbl.), per gal.	.35	35	.29
Belting—Present discounts from list in fair quantities (½ doz. rolls).			
Leather—List price, 24c. per lin. ft per inch of width for single ply.			
Medium grade	40–5%	40–5%	40–5%
Heavy grade	30–10%	30–10%	30–10%
Rubber transmission, 6-in., 6 ply, $1.83 per lin. ft.			
First grade	50%	50–10%	50%
Second grade	50–10%	60–5%	50–10%

*Per 175 lb. keg. †In 150-lb. bags. ‡Per 425 lb. barrel.

Comparative Warehouse Prices

New York	Unit	Current Price	Four Weeks Ago	One Year Ago
Soft steel bars	per lb.	$0.0324	$0.0324	$0.0324
Cold drawn shafting	per lb.	.04	.04	.0415
Brass rods	per lb	.17½	.16½	.16½
Solder (½ and ½)	per lb.	.41½	.41	.395
Cotton waste	per lb.	.13@.17½	13@.17½	15@22
Washers, cast iron (½ in.)	per 100 lb.	7.00	7 00	7.00
Emery disks, cloth, No. 1, 6 in. dia.	per 100	3.10	3.55	3.55
Lard cutting oil	per gal.	.55	.55	.55
Machine oil	per gal.	.35	.35	.35
Belting, leather, medium	off list	40–5%	40–5%	40%
Machine bolts, up to 1x30 in.	off list	40%	40%	40%

MISCELLANEOUS—Continued

	New York	Cleveland	Chicago
Abrasive materials—In sheets 9x11 in., No. 1 grade, per ream of 480 sheets:			
Flint paper	$5.40	$5. 84	$5.65
Emery paper	10. 71	11. 00	10. 71
Emery cloth	27 84	31. 12	29. 48
Emery disks, 6 in. dia., No. 1 grade, per 100:			
Paper	1 32	1. 45	1. 49
Cloth	3 10	3. 55	3.20
Fire clay, per 100 lb. bag		.60	. 75
Coke, prompt furnace, Connellsville	per net ton		3.25@ 3.50
Coke, prompt foundry, Connellsville	per net ton		4.25@ 5.00
White lead, dry or in oil	100 lb. kegs		New York, 15.25
Red lead, dry	100 lb. kegs		New York, 15.25
Red lead, in oil	100 lb. kegs		New York, 16 75

SHOP SUPPLIES

Machine bolts, ¼x1½-in., per 100, $1.70. Discount at New York warehouses on all sizes up to 1x30-in., 40%; 1⅛ and 1¼x3-in. up to 12-in., 15%; with cold punched hex. nuts up to 1-in. dia. (plus std. extra of 10%) 30%; with hot pressed hex. nuts up to 1x30-in. (plus std. extra of 10%) 35%.

Carriage bolts, ¼x1½-in., per 100, $1.00. Discount on all sizes up to 1x30-in., 30%.

Coach and lag screws, 1½x½in., $2.25 per 100, less 40%.

Tap bolts, 1½x½-in., $1.00 per 100. List plus 35% at New York warehouses.

Bolt ends, 1x12-in., 10c. per lb., less 40%.

Nuts, semi-finished, ¼x½-in., 2c. each. Discount 70% for ⅜-in and smaller and 65% for ½-in. and larger.
Case hardened ¼x½-in., 6c. each, less 50%.

Rivets, button heads, ⅜-in., ½-in.. 1-in. diam. x2¼-in. to 4½-in $5.00* per 100 lb. at New York warehouses; cone heads, same sizes, $5.20* per 100 lb. Rivets, ½x1-in and longer, 19c. per lb., less 50%. Same discount for tinned. EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ⅝-in. dia., 35c.; ¾-in. dia., 75c; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb. 50c.; countersunk heads, 45c.

Washers, cast iron, ½-in., $7.00* per 100 lb. at New York warehouses; ⅜-in., $6.00* per 100 lb.

*For immediate delivery from warehouse.

Machine Requirements and Industrial Construction

Machine Tools and Equipment Wanted

Ill., Chicago—A. K. Neebe, 3713 North Kedvale Ave.—machine tools, lathes, etc. for proposed 2 story, 40 x 132 ft. factory for manufacture of screw products, at 1716 North Adams Sts.

La., Shreveport — Cunningham Machine Works, 1229 Texas Ave.—4 ft. radial drill press.

Mass., Dorchester (Boston P. O.)—Havelock Association, 18 Tremont St., Boston—miscellaneous tools and equipment for large repair and service garage at Rhodes St., here. Estimated cost $65,000.

Mo., St. Louis—Wabash Railway Co., Railway Exchange Bldg.—24 in. slotter and motor driven floor grinder with two 16 in. wheel capacity.

O., Columbus—F. A. Carvin Co., 580 Hamilton St., D. Neal, Mgr.—(manufacture and assembly automobile bodies and cabs), metal working machinery for new plant.

O., Wellston—The Lit-War Co., (auto repair tools manufacturers) E. Litter, Ch. Engr.—2 drill presses, 2 milling machines, 1 large automatic unit., etc.

Wis., Abrams—Nero Development Co., A. Nero, Owner—machinery for manufacture of airplane accessories, etc. for proposed 2 story factory, here.

Wis., Milwaukee—Breitbach Auto Co., 142 8th St.—repair shop equipment for proposed garage and repair shop on National Ave.

Wis., Milwaukee—Wesley Steel Treating Co., 651 South Pierce St.—heat treating furnaces, etc. for proposed 2 story, 30 x 78 ft. factory, on South Pierce St. Estimated cost $40,000.

Que., Montreal — G. Desmarchais, 1664 Cotedes Neiges Rd.,—drill press, small lathe, small tools, etc.

Que., Montreal—Martel Garage Ltd., 87 Hadley St., F. Martel, 1156 Galt St., Purch. Agt.—bench lathe and miscellaneous tools for garage and auto repair shop.

Opportunities for Future Business

Calif., Alhambra—C. F. Braun & Co., 1200 Fremont Ave. plans the construction of additional workshops, etc. at plant for the manufacture of gasoline and absorption plants and power plant equipment.

Calif., Fresno—White Co., 11th and Mission Sts., San Francisco, awarded contract for the construction of 31 x 200 ft. motor truck shop on South Van Ness Ave., here. $42,000.

Calif., Los Angeles—Winhawk Corp., c/o Winter Constr. Co., 2404 West 7th St. awarded contract for the construction of garage on Spring St. Estimated cost $60,000.

Calif., Oakland—Western Drop Forge Co., South Boyle St., Los Angeles, plans the construction of factory, near 85th Ave. Estimated cost $40,000.

Conn., New Haven—New York, New Haven & Hartford R.R. Co., awarded contract for the construction of 1 story addition to car repair shop at Lamberton St. Yard, here. Estimated cost $40,000. Noted Aug. 26.

Ga., Atlanta—Birds-Potts Co., Inc., 376 Marietta St. is having plans prepared for the construction of foundry and machine plant. Private plans.

Ill., Chicago—Nelson Le Moon Truck Co., 840 North Kedzie Ave. awarded contract for the construction of 1 story, 120 x 150 ft. factory. Estimated cost $20,000.

Ill., East St. Louis—Southern Malleable Iron Co., 21st and Bond Ave. awarded contract for the construction of iron foundry, to replace plant, recently destroyed by fire.

Ind., Evansville—E. F. Goeke, awarded contract for the construction of repair shop, etc. at Main and John Sts. Estimated cost $26,000.

Ind., Evansville—Pride Bros. Co., is having plans prepared for the construction of 3 story, garage and repair shop, here. Estimated cost $50,000.

Ind., Fort Wayne—L. J. McCullock, 3106 Mannee St. awarded contract for the construction of 1 story, 85 x 120 ft. garage and service building on Mannee St. Estimated cost $27,000. Noted Aug. 19.

Ind., Fort Wayne—A. Werling, 1603 East Lewis St. will soon receive bids for the construction of 2 story, 50 x 151 ft. garage and repair shop, on State Blvd. Estimated cost $25,000

Ind., Garrett—Lamson Pipe Organ Co., is having plans prepared for the construction of 2 story, 50 x 100 ft. factory. Estimated cost $25,000. A. M. Strauss, Engr.

Ind., Gary—E. H. Gary, Chn., U. S. Steel Corporation, is having preliminary plans prepared for the construction of new tin plate plant, including 12 new blast furnaces, for the American Sheet and Tin Plate Plant. Estimated cost $9,000,000. Engineer not announced.

Ind., Indianapolis—Hayes Brothers, 236 West Vermont St. is having plans prepared for the construction of 66 x 200 ft. garage and repair shop. Estimated cost $25,000. Private plans.

Ind., Lawrenceville—Indiana Refining Co. will build 1 story, 40 x 500 ft. repair shop, here by day labor. Estimated cost $100,000.

Md., Baltimore—Motor Ramp Garage Co., awarded contract for the construction of 6 story, 79 x 120 and 32 x 55 ft. garage at 208 16th St.

Mass., Boston—Gulf Refining Co., 31 St. James St., awarded contract for the construction of 1 and 2 story, 100 x 180 ft. machine shop, at 2606 Washington St. Estimated cost $75,000.

Mass., Somerville—Winter Realty Co. Inc., 383 Bway., is receiving bids for the construction of 2 story, 100 x 120 ft. repair and service garage on Bond St. Estimated cost $100,000. Stebbins & Watkins, 164 Federal St., Boston, Archts. Noted Aug. 26.

Mass., South Walpole—Bird Machine Co. awarded contract for the construction of machine shop extension, here. $50,000.

Mass., Springfield—A. O. Standish, 176 Main St., is receiving bids for the construction of 1 story, 100 x 100 ft. garage, showroom and repair shop at 135 Main St. Estimated cost $40,000. H. J. Tessier, 534 Main St., Archt. Noted Sept. 16.

Mass., Waltham — Waltham Grinding Wheel Co., 115 Beacon St. awarded contract for the construction of 1 story, factory addition, on Beacon St.

Mo., Kansas City—Columbian Steel Tank Co., 1507 West 12th St., plans 4 story addition to plant, here.

Mo., Kansas City—Missouri Casket Co., 2106 East 9th St. awarded contract for the construction of 3 story, 45 x 120 ft. factory. Estimated cost $65,000. H. Von Unwerth, 705 Finance Bldg., Engr. Noted July 29.

Mo., St. Louis—Vesper Buick Auto Co., Grand and Lindell Blvds. awarded contract for the construction of 2 story, auto service building at 3900 Block, West Pine Blvd. Estimated cost $200,000.

N. J., Atlantic City—D. Dorf, 15 Park Row, New York City, is having plans prepared for the construction of 6 story, 100 x 100 ft. garage, at Mississippi and Pacif St. A. F. Amodie, Commerce Bldg., Arch.

O., Ashland—Department Highways and Public Works, Ohio-Hartman Bldg., Columbus, awarded contract for the construction of 80 x 120 ft. garage, here. $22,000. Noted Sept. 16.

O., Cleveland—Art & Bronze Co., 1782 East 37th St. is having plans prepared for the construction of 2 story, 34 x 70 x 125 ft. foundry, on East 43rd St., near Chester Ave. Estimated cost $40,000. W. J. Wefel, 5716 Euclid Ave. Archt.

O., Cleveland—J. Rutkowski, Pres. Cleveland Structural Steel Co., 660 Park Ave. is having plans prepared for the construction of 2 story, 50 x 250 ft. auto sales and service building at 6800 Bway. Estimated cost $150,000. W. J. Werfel, 5716 Euclid Ave., Archt. Broadway Chevrolet Sales Co. Lessee.

O., Fairport — Fairport & Painesville, Eastern R.R. Co., Painesville, awarded contract for the construction of machine and repair shop and roundhouse, here. Estimated cost $75,000. Noted Sept. 2.

O., Rocky River—River Cliff Co., 19520 Frazier Dr. has had plans prepared for the construction of 1 story, 107 x 121 ft. garage. Estimated cost $100,000. W. S. Ferguson Co., 1900 Euclid Bldg., Archt.

Pa., Philadelphia—American La France Fire Engine Co. awarded contract for the construction of 1 story, 100 x 210 ft. sales and service building at 25th and Westmore Sts. Estimated cost $38,000. Noted Aug. 26.

Pa., Philadelphia—City, Department of Transit will soon award contract for the construction of shop buildings at Fern Rock Service Yards, Broad Street Subway. Noted Sept. 2.

Pa., Philadelphia — Philadelphia Gear Works, Richmond and Tioga Sts. will receive bids until September 29, for the construction of 1 story, 134 x 398 ft. plant for manufacture of wheels, etc. at Erie Ave. and G. Sts. H. W. Caster, St. Gerard Bldg., Archt.

Pa., Philadelphia — Smith-Drum Co., Allegheny and Lawrence Sts. is having plans prepared for the construction of 1 story 100 x 125 ft. plant at Allegheny and Lawrence Sts. J. S. Himsohn, Broad and Gerard Sts., Archt.

Pa., Pittsburgh— National Casket Co., Rudsdal St. awarded contract for the construction of 1 and 2 story, 50 x 60 ft. factory on Rudsdale Ave. Estimated cost $40,000. F. Bruner Co., Columbus Bank Bldg., Engr.

Wis., Cedarburg — American Electric Motors, Inc., 57 Erie St., Milwaukee, awarded general contract for the construction of 1 story, 142 x 166 ft. factory, here. Noted September 16.

Wis., Milwaukee—Federal Tire & Supply Co., 503 Bway., is having plans prepared for the construction of 2 story, 130 x 135 ft. garage on National Ave. Estimated cost $150,000. Architect and engineer not selected.

Wis., Racine—Harvey Spring & Forging Co. 17th St., awarded contract for the construction of 1 story, 52 x 160 ft. factory addition, on 17th St. Estimated cost $40,000.

Wis., West Allis—Allis Chalmers Mfg. Co., 62nd and National Aves. awarded contract for the construction of 2 story shop, here. Estimated cost $50,000.